MANORAMA

TELL ME WHY

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100 MILESTONES IN CHEMISTRY

MANORAMA
TELL ME WHY

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FROM THE HOUSE OF MAGIC POT, THE WEEK, MANORAMA YEARBOOK, VANITHA & THE MALAYALA MANORAMA DAILY

The Midas touch of Chemistry

One simple touch from him, and everything turned into gold! King Midas was the only man in mythology who knew the secret of alchemy.

Ever since this story spread, Man spent countless sleepless nights. He taxed his brain, day in and day out, and conduct umpteen experiments. However, these eager endeavours didn't take him anywhere. But this was, in fact, a blessing in disguise. Thanks to these Herculean efforts, Man later made a tryst with chemistry. And this changed his life from tip to toe.

Chemistry itself has a Midas touch. A cruise through its history is a fascinating experience. Get ready to experience it, as this issue of Tell Me Why brings you a hundred milestones in chemistry.

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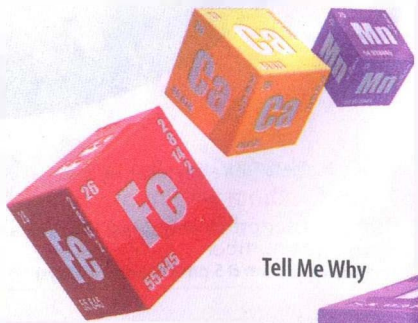
FROM ALCHEMY TO CHEMISTRY

Where did the first theory of matter come from?

We can trace the origin of the theory of matter to the Ancient Greeks. In the 5th century BC, Empedocles, a Greek philosopher, put forward the theory that all matter was made up of four elements- fire, air, water, and earth. The ratio of these elements to one another affected the properties of matter.

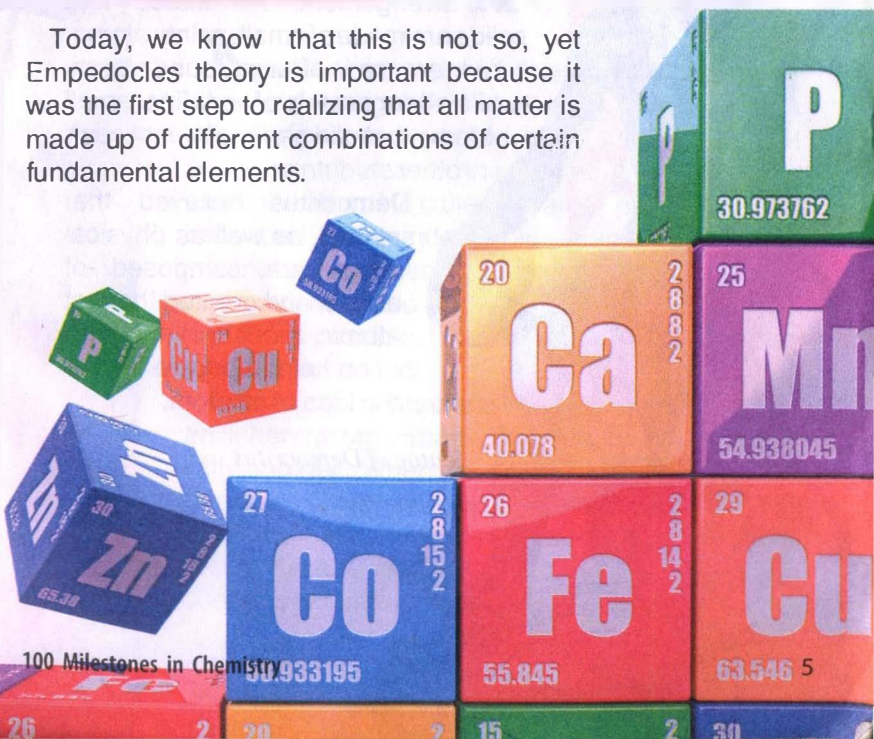
Empedocles also stated that nothing is ever created or destroyed- matter is just transformed from one form to another, as the ratio of these elements to one another changes.



Aristotle's Theory

Aristotle, the great Greek philosopher, stated that matter was a combination of four elements -earth, air, fire, and water- in different proportions.

Today, we know that this is not so, yet Empedocles theory is important because it was the first step to realizing that all matter is made up of different combinations of certain fundamental elements.



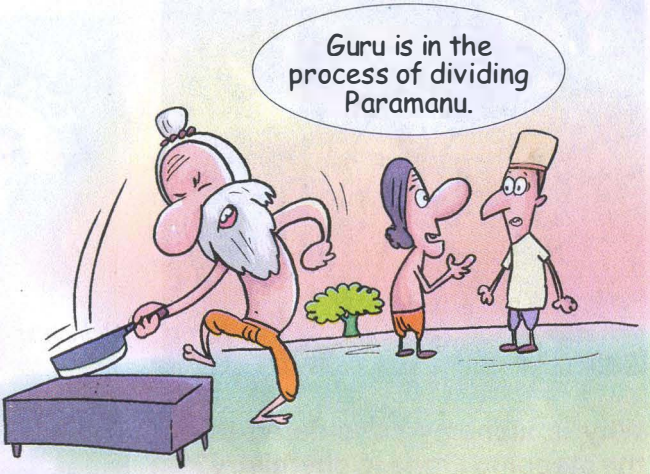
Why is Democritus' atomic theory important?

About 400 BC, the Greek philosopher Democritus suggested that all matter is formed of different types of tiny invisible particles, and that the properties of these particles also determined the properties of the matter. He named these particles atoms, and stated that they were solid, indestructible, and always moving.

According to Democritus, atoms differed in size, shape, mass, position, and arrangement. He stated that solids are made of small, pointy atoms, liquids are made of large, round atoms, while oils are made of very fine, small atoms that can easily slip past each other.

Democritus believed that spiritual, as well as physical things are composed of atoms, and created the first atomic model. His contribution helped people understand the idea of an atom.

Statue of Democritus

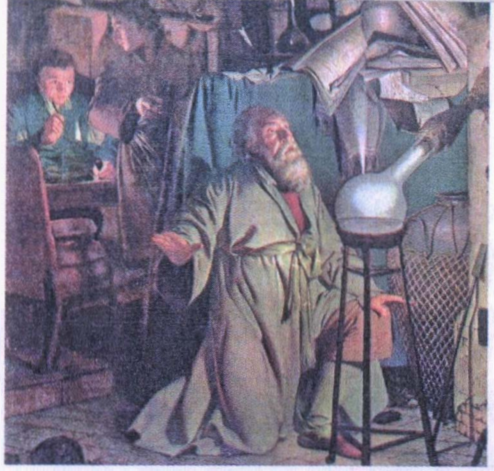


Why are Kanada's contributions to theories about the atom invaluable?

Kanada was an Indian sage and philosopher who lived during the 6th century BC. He founded a school of philosophy called the Vaisheshika School which contributed to the development of ideas about the atom. He called the atom 'paramanu' and described it as an indestructible particle of matter.

Kanada explained that when matter is divided and subdivided, we reach a stage beyond which no division is possible, and this indivisible element of matter is paramanu.

Expanding on his ideas, Kanada observed that an inherent urge made one paramanu combine with another. When two paramanu belonging to one class of substance combined, a dwyanuka- or what we call a binary molecule today- was the result. Kanada also put forth the idea of chemical changes occurring because of various factors.



Alchemist - A Painting

Why is alchemy considered to be the stepping stone to chemistry?

Alchemy was an ancient philosophy and practice that sought to change one element into another. The practice of alchemy was widespread amongst the ancient cultures of Egypt, Mesopotamia, China, India, and Greece.

The alchemists believed that metals could be converted into gold with the aid of a marvelous substance called the philosopher's stone, which they never succeeded in finding, or making.

Yet alchemists have made notable contributions to the field of chemistry. The alchemists helped in the development of many of the apparatus that is used in laboratories today, and their experiments led to the discovery of nitric acid, sulphuric acid and hydrochloric acid.

Father of Distillery

The first recipe for the fractional distillation of alcohol was provided by Magister Salernus, a medieval alchemist. Fractional distillation is the separation of mixtures into their component fractions or parts, by boiling. Magister Salernus died in 1167, and is often called the 'Father of Distillery'.

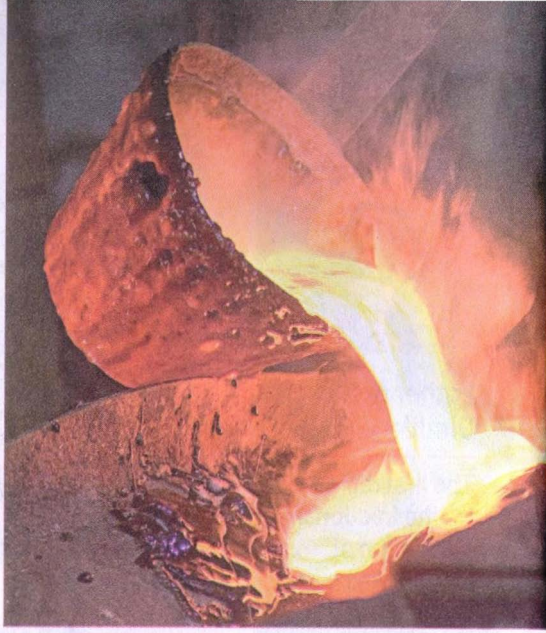
Why is Jabir Ibn Hayyan considered a great alchemist?

Jabir is considered the founder of experimental chemistry. He practiced medicine and alchemy around 776 AD, and was the first to acquire his information from experiments, observation, and scientific conclusion.

Jabir Ibn Hayyan

Jabir's works that depended on laboratory experiments were the most important serious trials in studying nature in an accurate scientific way. The procedures he pursued in his researches are almost identical to those followed today.

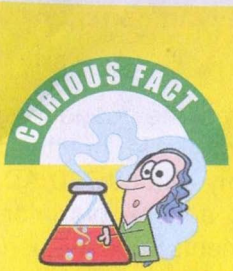
Jabir had so many discoveries and works that they called him 'the master of chemists.'



Why is metallurgy considered an older science than chemistry?

Metallurgy is a branch of chemistry that deals with the preparation, purification, and use of metals. But though we say that it is a branch of chemistry, it actually developed before chemistry. This is because the present-day use of metals is the culmination of a long path of development, extending over approximately 6,500 years.

It is generally agreed that the first known metals were gold, silver, and copper. Nuggets of gold found in the sand and gravel of riverbeds were probably one of the first metal known to Man.



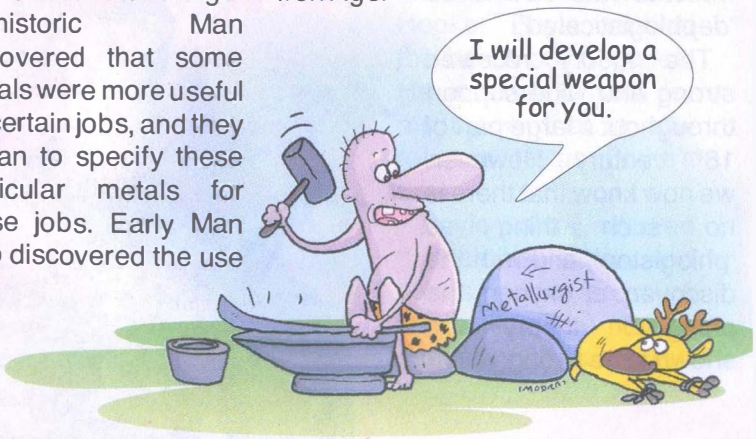
The Philosopher's Stone

Alchemists believed that there was a unique substance that would turn base metals like iron into gold. They called it the Philosopher's Stone. Today we know that they were wrong, for such a substance has never been found so far.

Nagarjuna

Nagarjuna was an Indian metallurgist and chemist. He lived in the first century, and was from Gujarat. His works give us an idea about the status of metallurgy and alchemy in India at that time. He describes the extraction of metals such as silver, gold, tin, and copper from their ores, and their purification.

These early metals became known and used for ornaments and tools during the latter part of the Stone Age. Prehistoric Man discovered that some metals were more useful for certain jobs, and they began to specify these particular metals for these jobs. Early Man also discovered the use of alloys which combined two or more metals. In time, certain periods in history came to be named after these metals, like the Bronze Age, and the Iron Age.



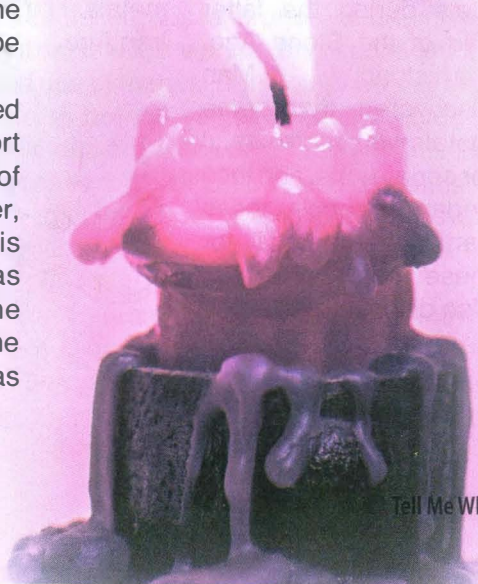
What was the phlogiston theory?

For many years before the discovery of oxygen, people believed that all flammable materials contained a fire-like element called 'phlogiston', which was released during burning. The idea was first put forward in 1667 by Johann Joachim Becher.

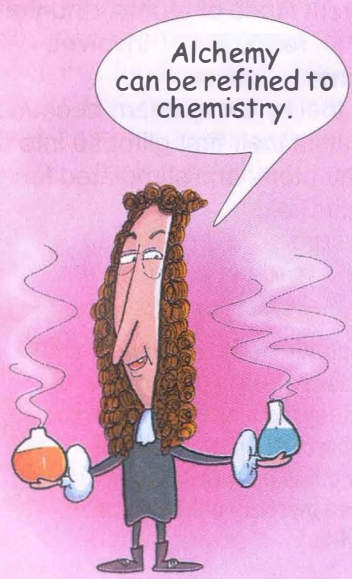
According to him, phlogiston was without colour, taste, odour, or substance. When the flammable material was burned, the phlogiston was set free, and the material was said to be 'dephlogisticated'.

The theory received strong and wide support throughout a large part of 18th century. However, we now know that there is no such thing as 'phlogiston', and with the discovery of oxygen, the phlogiston theory was shown to be wrong.

Johann Joachim Becher



Robert Boyle



Why is Robert Boyle considered a pioneer of modern chemistry?

Robert Boyle was one of the pioneers of modern experimental scientific methods.

Modern chemistry began to emerge when Robert Boyle made a clear distinction between chemistry and alchemy in 1660. He rejected the earlier theories about the nature of matter, and compiled the first list of elements. In a series of experiments with another scientist, Robert Hooke, Boyle studied the behaviour of gases. He is most famous for his theory that is now referred to as Boyle's Law.

Boyle also showed that air has mass, and gases exert pressure against the things containing them.

John Dalton

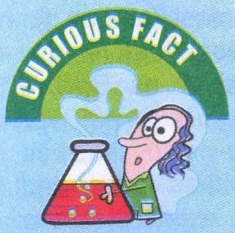
Why is Dalton's atomic theory considered a breakthrough in chemistry?

John Dalton was an English school-teacher. In 1805, he developed the atomic theory which is considered to be one of the most significant breakthroughs in chemistry.

According to this theory, all matter is made up of atoms that are indivisible and indestructible- and all atoms of a given element are identical in their mass and properties.

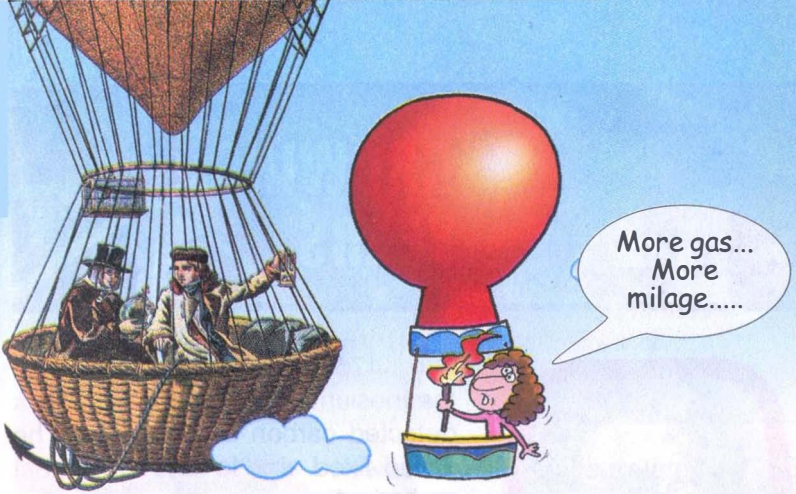
Dalton further stated that compounds are formed by a combination of two or more different kinds of atoms, and that a chemical reaction involves a rearrangement of atoms.

Dalton's theory is important because it gave scientists their first glimpse into the nature of the atom, and stimulated further studies in this field.



Doctor Killer

Alchemists conducted many experiments to cure diseases so as to prolong life- but more often, they did more harm than good. The first emperor of China asked his alchemist to come up with a potion for eternal life. The alchemist prescribed mercury pills that made the Emperor insane and he lost his life.



Why is Gay Lussac's Law important?

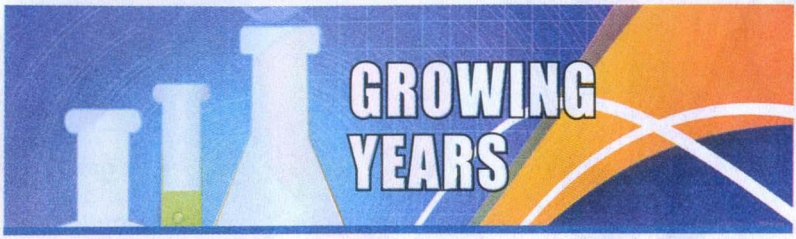
Gay Lussac was a French chemist who made an important discovery about the fundamental properties of gases. He discovered that, when gases combine together to form other gases, their relative combining volumes and the volume of the product can be expressed by simple whole numbers. This is known as Gay Lussac's law of combining volume.

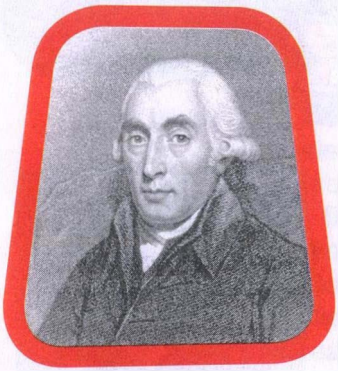
There is a second law, which concerns the relationship between the pressure and temperature of a gas.

Gay Lussac's laws are important because they helped us to understand not just the properties of gases, but also explained many things that we see in daily life.

Latrochemistry

Latrochemistry is a fusion of both chemistry and medicine. Latrochemists believed that good health depended on a specific balance of bodily fluids, and provided chemical solutions to medical problems. Latrochemistry was very popular between 1525 and 1660, especially in the area of Europe known as Flanders.





Joseph Black

How was carbon dioxide detected?

Joseph Black was a Scottish chemist who lived in the 18th century. Black was always a meticulous chemist, keeping careful note of all his results. It was this which led to his discovery of carbon dioxide.

In 1754, while working with magnesium carbonate, Black detected carbon dioxide, which he called fixed air. He also found that carbon dioxide is present in the atmosphere.

Joseph Black is considered one of the world's most eminent chemists, and one of the founding fathers of the science of chemistry.

Why is the discovery of hydrogen a milestone in chemistry?

Hydrogen was recognized as an element in 1766 by Henry Cavendish, an English chemist and physicist. He collected it during an acid metal reaction, and described it as 'inflammable air from metals'. In 1781, he also found that hydrogen produces water when burned. Cavendish described hydrogen's properties correctly, but was mistaken when he believed that it was produced from the metal, rather than the acid.

Boyle and Hooke

Robert Boyle employed Robert Hooke to help him with his experiments. Together, they built the air pump used in many of Boyle's important experiments.
In 1661, Boyle published his famous work 'The Sceptical Chymist' or 'Chymico-Physical Doubts & Paradoxes'.

Henry Cavendish

It wasn't until a few years later, in 1783, that hydrogen was given its name. The word hydrogen comes from the Greek word 'hydro', meaning water, and 'genes', meaning creator or generator.

The discovery of hydrogen is one of the milestones in chemistry because hydrogen is the lightest, simplest, and most commonly found chemical element in the Universe.

Priestly's Lab

Joseph Priestly

What do we know about the discovery of oxygen?

Oxygen was discovered independently by Carl Wilhelm Scheele and Joseph Priestly, but it is Priestly who is credited with this discovery.

On August 1st, 1774, Joseph Priestly, an English scientist, obtained a colourless gas by heating red mercuric oxide. Finding that a candle would burn in it, and that a mouse would thrive in this gas, he called it 'dephlogisticated air'.

The following October, when he went to Paris, he informed the French chemist Lavoisier how he obtained the new 'air'. Lavoisier repeated Priestly's experiments, conducted intensive investigations from which he derived the elementary nature of oxygen and recognized it as the 'active' part of the atmosphere. He also gave it its name. The discovery of oxygen and its properties ushered in a new era in chemistry.

Lavoisier

Why is Lavoisier considered to be one of the founders of modern chemistry?

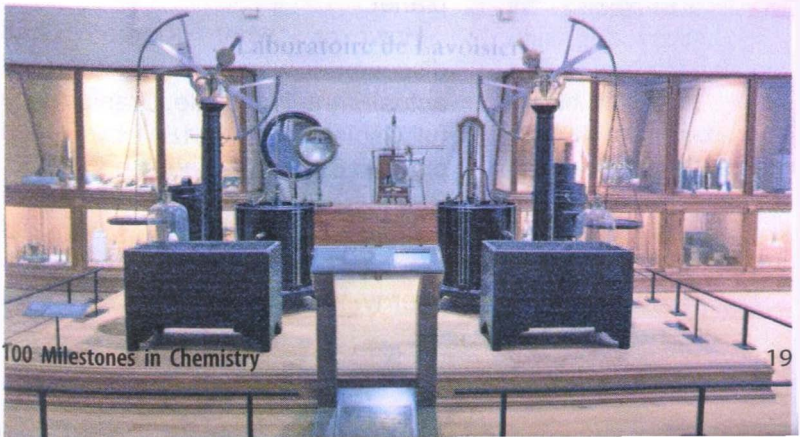
Many great chemists are considered to be the founders of modern chemistry- and Lavoisier, a French scientist, is one of the most important of them.

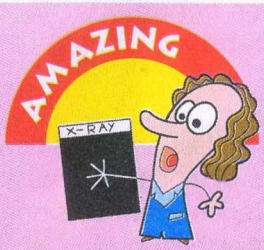
Lavoisier started working on such processes as combustion, respiration, and the oxidation of metals in 1772. His work proved the old prevailing theories which dealt with the combustion principle called Phlogiston, were wrong.

Lavoisier wrote the book 'Elements of Chemistry,' in 1787. He compiled the first complete list of elements for that time, discovered and named oxygen and hydrogen, and helped develop the metric system.

Lavoisier also helped revise and standardize chemical nomenclature. His revolutionary approaches influenced scientists of the future.

Lavoisier's Lab





Phosphorous Maker

Hennig Brand, a German alchemist stored 50 buckets of human urine for six months, and then heated the urine with sand and water. To his astonishment, the substance burst into a fierce white light – he had unknowingly, discovered phosphorous!

Klaproth

Why was the discovery of uranium so important?

In 1789, a German scientist Martin Heinrich Klaproth discovered uranium.

Klaproth was conducting an experiment with a yellow compound and pitchblende. He got a yellowish substance as the result. He heated this substance to drive out the oxygen, and he got what he thought was a new element, which he named uranium after the newly discovered planet.

However, what Klaproth had discovered was not uranium, but actually uranium oxide. Uranium was fully isolated only in 1841 by French chemist Eugene Peligot- and in 1896, Becquerel discovered its radioactive properties. The importance of uranium lies in its use for nuclear energy.

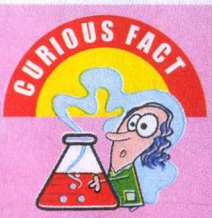
Why is Alessandro Volta famous?

Alessandro Volta, an Italian, is famous for his discovery of a practical way of generating electricity.

Volta showed that electric currents could be generated by appropriately connecting metals or wires. Using zinc and copper wires, and saline solutions, Volta successfully constructed the first electric battery, widely considered to be one of the greatest breakthroughs in the history of science and mankind.

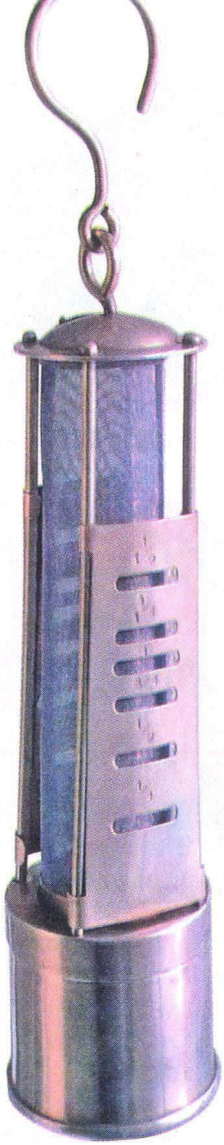
He also found out that the inflammable gas which creates bubbles in marshes was methane, which is now used as a fuel.

Alessandro Volta



Purple Gas

Iodine was discovered by Bernard Courtois, in 1811. He observed purple vapours rising from kelp ashes to which he had added sulfuric acid and heated. When the vapours condensed, they formed crystals, which were later proved to be an element.



Davy's Safety Lamp

Why is Humphry Davy remembered to this day?

Sir Humphry Davy was a great chemist and inventor. He is highly regarded for his work on various alkali and alkaline earth metals, and for his valuable contributions regarding the findings of the elemental nature of chlorine and iodine.

Davy was the first scientist to reveal the peculiar, exhilarating, or intoxicating properties of nitrous oxide gas.

Humphry Davy

Davy is best remembered however, for the invention of the Davy's lamp. In those days, the major cause of explosions in coal mines was the presence of methane in mine. Methane was highly inflammatory, and caught fire because of the lamps used by the miners.

Davy designed a safety lamp in 1815, and it prevented such disasters. Davy's lamp saved many lives, and proved to be huge a boon to the mining industry.

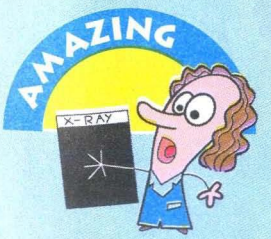
J.J. Berzelius

Why are Jon Jacob Berzelius' contributions considered milestones in chemistry?

Jon Jacob Berzelius was a Swedish chemist who worked out the atomic weights of nearly all the elements known at that time- and he created a table of elements based on relative atomic weights.

Berzelius was the first to use the chemical notation system in use today, with symbols for elements and numbers to denote the proportions. For example, oxygen was O and copper Cu. This was an important milestone, because with the isolation and identification of several new elements and compounds, there was a need for a uniform and convenient chemical notation.

Berzelius fulfilled this need - and by doing so, gave chemistry a language of its own.



Frankenstein

The work of the chemists and alchemists in the 17th and 18th centuries inspired the book 'Frankenstein.' Written by Mary Shelley, the book is the story of a scientist who creates a monster from human body parts, and brings it to life- only to be killed by his own creation.

Why is Avogadro's hypothesis important?

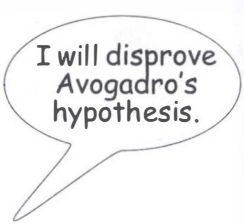
Avogadro's hypothesis is a principle stated in 1811 by the Italian chemist Amedeo Avogadro.

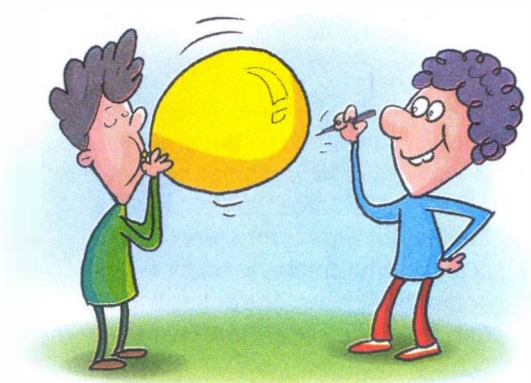
According to this hypothesis, "equal volumes of gases at the same temperature and pressure contain the same number of molecules, regardless of their chemical nature and physical properties."

In other words, the more gas we have, the greater the volume it will occupy, provided the pressure of the gas and its temperature remain unchanged.

The number of molecules remains the same for the lightest gas –hydrogen- as for a heavy gas such as carbon dioxide or bromine. Avogadro worked out this number to be 6.022×10^{23}. This number is known as Avogadro's number, and it is one of the fundamental constants of chemistry.

Avogadro





Why is the beginning of organic chemistry interesting?

Organic chemistry is the study of carbon and its compounds, and the study of the chemistry of life.

The history of organic chemistry can be traced back to ancient times when medicine men extracted chemicals from plants and animals to treat members of their tribes. They didn't label their work as 'organic chemistry', they simply kept records of the useful properties and uses of things like willow bark which was used as a pain killer.

Organic chemistry was first defined as a branch of modern science in the early 1800s by Jon Jacob Berzelius. He classified chemical compounds into two main groups- organic, if they originated in living or once-living matter, and inorganic, if they came from 'mineral' or non-living matter.

However, this perception changed in 1828 when Fredrich Wohler, discovered that urea - an organic compound - could be made by heating ammonium cyanate, an inorganic compound, and his discovery was a turning point in science history.

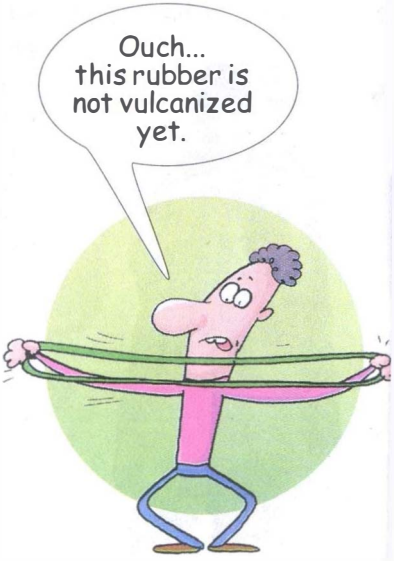
Statue of J J. Berzelius

Why is the vulcanization of rubber important to the rubber industry?

Rubber is a very important product made from the sap of the rubber tree. It is used today to make a variety of products from erasers for pencils, to tyres. However, natural rubber has many disadvantages.

In 1839, Charles Goodyear discovered a process that overcame these problems, and is responsible for making rubber one of today's most useful materials. He accidentally dropped a mixture of rubber and sulfur into a fire. When he retrieved the material, it was no longer sticky. It did not get brittle at cold temperatures, and when it was stretched, it snapped back to its original shape. This new discovery by Goodyear was called vulcanization after Vulcan, the Roman God of fire.

It is a chemical process that increases the strength and durability of rubber. It also makes rubber retain its elasticity at a much wider range of temperatures, making vulcanized rubber more useful for many purposes.



Why is Justus Von Liebig credited with ushering changes in agricultural chemistry?

Justus Von Liebig was a German chemist who made major contributions to agricultural and biological chemistry.

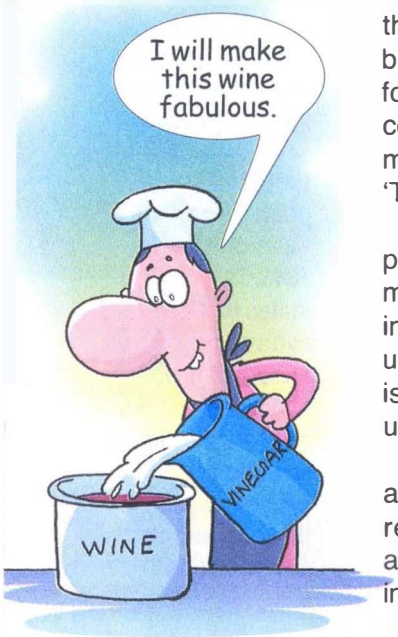
Liebig devised the modern laboratory -oriented teaching method, and for such innovations, he is regarded as one of the greatest chemistry teachers of all time. He is also known as the Father of Agricultural Chemistry for his discovery of nitrogen as an essential plant nutrient.

Liebig presented his famous 'Law of the Minimum,' which explained the effect of individual nutrients on crops. Liebig pioneered the production and use of artificial fertilizers. Liebig played an important role in the development of modern agricultural industry.

Hess's Law

Henri Hess published an important law in 1840. This law states that heat evolved or absorbed in a chemical process remains the same, whether the process takes place in one, or several steps.

Why was the first preparation of acetic acid in a laboratory a notable event?



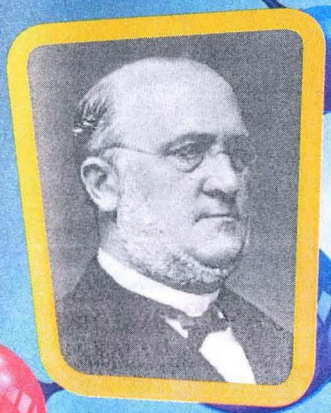
In the 19th century, it was believed that organic chemicals found in our body were created by a mysterious force called the 'life force', and that they could not be made from inorganic materials. This theory was known as 'The Theory of Vitalism.'

Herman Kolbe, a German scientist, proved this theory to be wrong when he made acetic acid, an organic chemical, in his laboratory. Acetic acid has many uses, the most common being when it is mixed with water to make vinegar. It used to be made by fermenting wine.

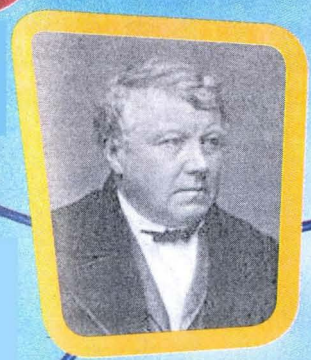
Kolbe's method of preparing acetic acid is an important milestone, for it represented the first total synthesis of an organic compound-acetic acid- from inorganic materials.

Triads

A German scientist called Johann Dobereiner put forward a law called the 'Law of Triads' in 1817. Each of Dobereiner's triads was a group of three elements. The appearance and reactions of the elements in a triad were similar to each other.



Herman Kolbe



Schonbein

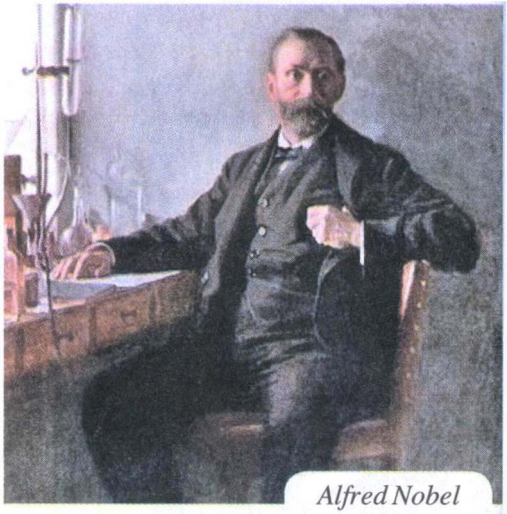
Why is the discovery of guncotton an accidental one?

Schonbein was a German chemist who discovered and named ozone. He is also famous for his discovery of guncotton, or nitrocellulose.

Nitrocellulose is a compound that has proved to be very useful as a form of smokeless gunpowder. Schonbein discovered it quite by accident. He was doing an experiment in his wife's kitchen, when he spilled some nitric acid and sulfuric acid. He quickly wiped up the mess with his wife's cotton apron, and hung it over the hot stove to dry. To his amazement, the cloth burst into flames and disappeared! Schönbein recognized the importance of this accident, and he experimented a lot. At last, smokeless gunpowder was born. Later, it was used in the battlefield as an explosive.

Why is the discovery of dynamite one of the landmarks of chemistry?

In 1846, nitroglycerine was invented by an Italian scientist, Ascanio Sobero. Nitroglycerine was very explosive, but since it was a liquid, it was very risky to use. In 1866, Alfred Nobel, a Swedish inventor, mixed nitroglycerine with silica, and got a highly explosive paste. He called this paste dynamite- derived from the Greek 'dynamis' meaning 'power'-and received a patent for the process in 1867.

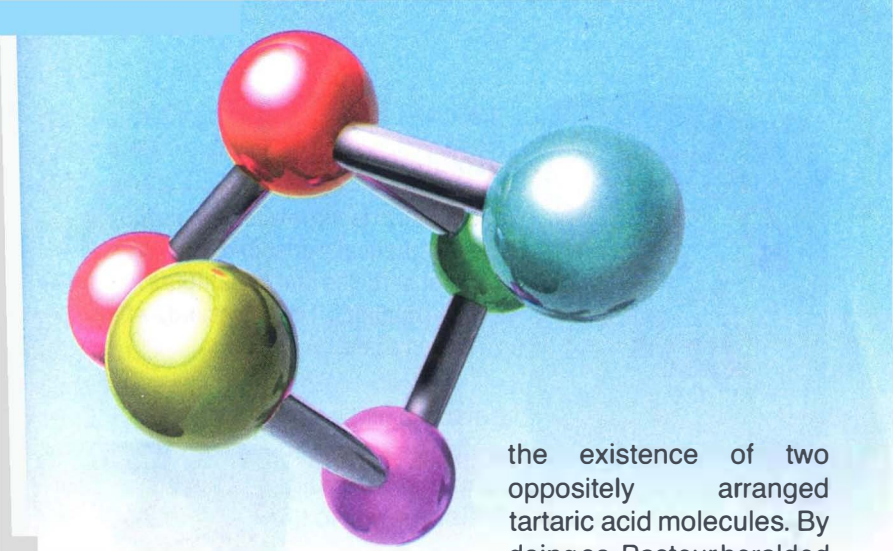


Alfred Nobel

Nobel had intended to market dynamite as an alternative to gunpowder for large-scale construction work such as roads and tunnel building. However, dynamite also came to be used in war by the military, and by revolutionaries as a weapon.

Dynamite Prize

Alfred Nobel made millions from the invention of dynamite. When he died, his will contained instructions that his wealth should be used to institute an international prize named after him.

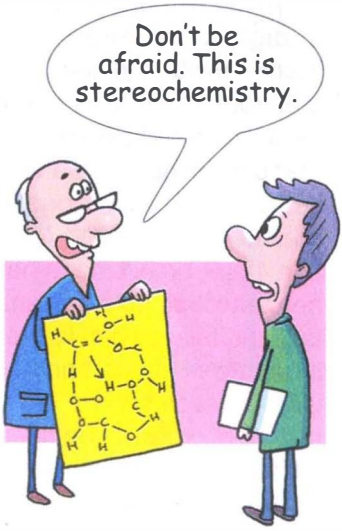


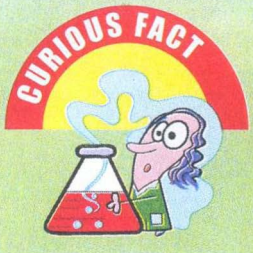
What is stereochemistry?

Stereochemistry is a branch of chemistry that deals with the study of three-dimensional configuration of atoms that make up a molecule.

Stereochemistry is also known as 3D chemistry because the prefix 'stereo' means 'three-dimensionality'. Stereochemistry is of particular interest to biochemists, because the reactivity and toxicity of molecules change with their stereochemistry.

Louis Pasteur can be considered to be the first stereochemist for his observations in 1849 on molecules of tartaric acid. He separated the oppositely arranged crystals of tartaric acid by handpicking, and through his investigations, proved the existence of two oppositely arranged tartaric acid molecules. By doing so, Pasteur heralded the birth of stereochemistry as a separate branch of chemistry.

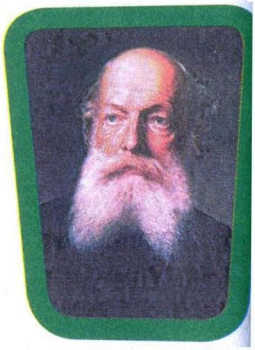




Absolute Zero

Absolute zero is the lowest temperature that is theoretically possible, at which the motion of particles that constitutes heat would be minimal. It is expressed as 0K on a Kelvin scale.

Why is Kekule's work of great importance?



Kekule

Friedrich August Kekule was a German chemist who laid the foundation for the modern structural theory in organic chemistry. He was the brain behind the theory of chemical structure.

When he began his studies, the structure of organic molecules were unknown. His theory gives the idea of the number of electrons in the outer shell of carbon- the tetra valence of carbon. In 1858, he showed that carbon has a valence of four, and that its atoms can link together to form long chains.

In 1865, he is said to have dreamt of the benzene molecule as a snake biting its own tail, and this led him to the discovery of the structure of six-carbon benzene ring. This was a revolutionary achievement in the history of organic chemistry.

Kekule laid the groundwork for modern structural theory in organic chemistry.

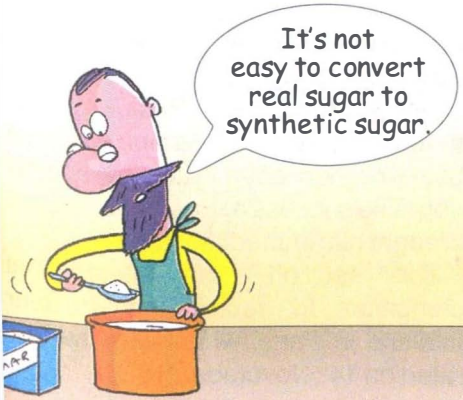
Why did the work of Emil Fischer give a new dimension to organic chemistry?

Hermann Emil Fischer, a German chemist, is remembered for his production of synthetic sugars, and as a byproduct, several enzymes.

He was a winner of the Nobel Prize in 1902. Fischer synthesized an amazing 130 related compounds. He also determined structures for glucose, fructose, mannose, and a group of sugars called hexoses.

Fischer implemented the classical chemical methods into organic chemistry, in an effort to demonstrate the structure of biological compounds like sugars, and proteins.

It was this noteworthy work with sugars that won Fischer the Nobel Prize in chemistry in 1902.



Fischer

First Dye

The first synthetic dye was made by William Henry Perkin from chemicals derived from coal tar. It was mauve in colour. It laid the foundation for the highly innovative chemical industry of synthetic dyestuffs. Studies on the structure of molecules play an important role in this industry.

Why are the works of Louis Pasteur milestones in chemistry?

Louis Pasteur was a French chemist and microbiologist whose contributions to science, technology, and medicine are unparalleled. He discovered that microbes were responsible for souring alcohol, and came up with the process of pasteurization, where bacteria is destroyed by heating beverages, and then allowing them to cool. Today, this process is known as pasteurization.

Many of Pasteur's experiments supported the germ theory of disease, for they helped show that microorganisms are the true cause of many diseases.

Pasteur went on to identify causes and develop vaccinations for diseases such as anthrax, cholera, TB, and smallpox.

Louis Pasteur

On July 6th, 1885, Pasteur vaccinated Joseph Meister, a nine -year-old boy who had been bitten by a rabid dog. The success of Pasteur's vaccine brought him immediate fame.

This set off an international campaign to found the Pasteur Institute in Paris, which was inaugurated on 14th November, 1888.

What is spectroscopy?

Spectroscopy is a scientific measurement technique. It measures light that is emitted, absorbed, or scattered by materials and can be used to study, identify, and quantify those materials.

Different substances give off a different spectrum of light when they vaporize, and each substance produces a unique spectrum, almost like a fingerprint.

Spectroscopy was discovered in 1859 by Gustav Robert Kirchhoff and Robert Bunsen. They determined that each gas had its own signature spectrum.

Bunsen and Kirchhoff together developed the Bunsen-Kirchhoff spectroscope in 1859.

Gustav Robert Kirchhoff (left) and Robert Bunsen (right)

Star Number

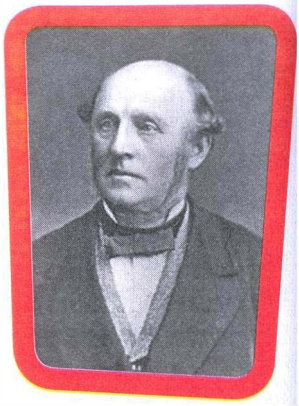
In 1865, Johann Josef Loschmidt was able to determine how many molecules are present in a given volume of gas. He placed it at 6×10^{23} molecules per gram molecular weight, or 'mole' of a gas. This number was known in England and America as Avogadro's number, and in Europe as the 'Loschmidt Constant.'

What are the contributions of Alexander Parkes to plastic chemistry?

It was in the 19th and 20th centuries that plastics, we know them today, were invented.

Charles Goodyear showed that rubber could be a source of plastic, but it is Parkes, an Englishman, who is credited with inventing the first man-made plastic, which he patented as Parkesine in 1856.

Alexander Parkes will always be remembered as the man who introduced fully synthetic plastic to the world. Later, scientists perfected the techniques in plastic chemistry to make plastic one of the most important materials ever created by Man.



Alexander Parkes

Why is the periodic table an important development in chemistry?

The periodic table gives us information about element symbols, atomic numbers, and atomic weights. It brings order to information about the chemical elements and helps chemists to understand why elements react as they do.

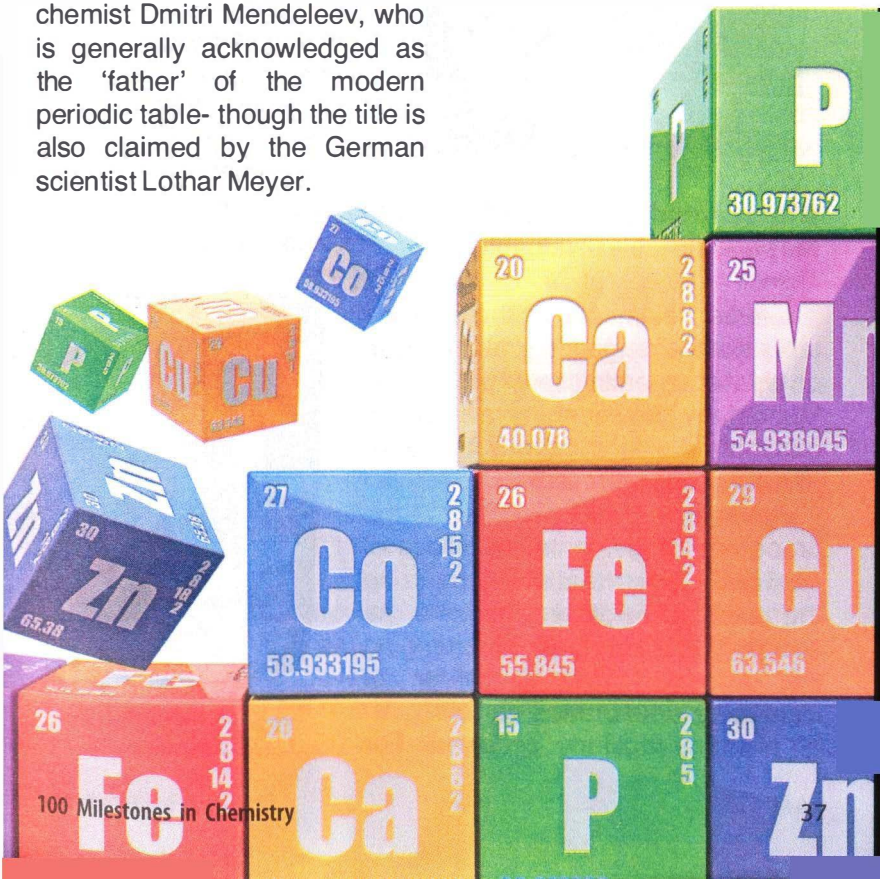
One of the earliest attempts to organize the elements based on

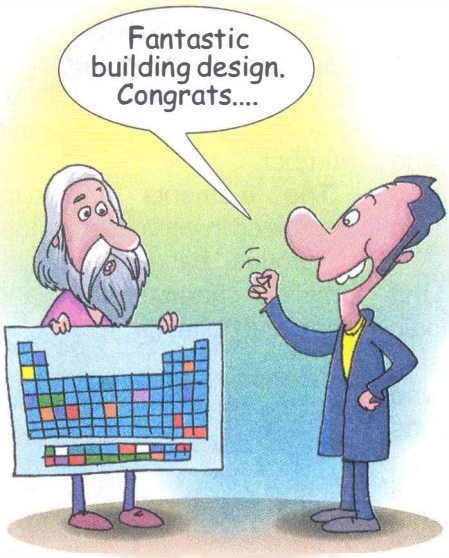
their chemical and physical properties was made by German chemist Johann Dobereiner. However, it was the English chemist John Newlands who attempted to classify the known elements of his day based on their atomic weight.

The next milestone in the development of the periodic table was set by the Russian chemist Dmitri Mendeleev, who is generally acknowledged as the 'father' of the modern periodic table- though the title is also claimed by the German scientist Lothar Meyer.

Today, the periodic table organizes the elements in horizontal rows, or periods, by order of increasing atomic number.

The elements are also organized in vertical columns, or groups, based on similar physical characteristics, and chemical behavior.





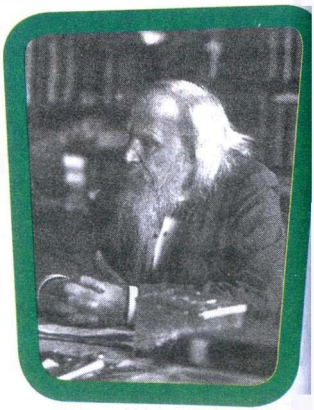
Why is Mendeleev's contribution to the periodic table invaluable?

Earlier, elements in the periodic table were arranged in groups based on a set of repeating set of properties. Mendeleev, however, arranged the elements in order of increasing atomic mass.

Mendeleev had written the properties of elements on pieces of card and it is said that after organizing the cards while playing solitaire, he suddenly realized that by arranging the element cards in order of increasing atomic mass, certain types of element regularly occurred. For example, a reactive non-metal was directly followed by a very reactive light metal, then a less reactive light metal.

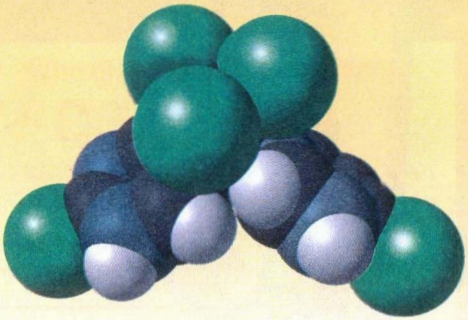
Mendeleev's work is considered invaluable, because he put elements into their correct places in the periodic table.

His greatness lies in the fact that not only did he leave space for elements that were not yet discovered, but he predicted properties of five of these elements and their compounds.



Mendeleev

Hermann Müller



DDT Molecule

Why is the synthesis of DDT a historic event in chemistry?

DDT's full form is very long-it is dichloro-diphenyl-trichloroethane.

DDT is a synthetic chemical compound that is made in a laboratory. DDT was first synthesized in 1874 by the German chemist Othmar Zeidler. However, it wasn't until 1939 that Swiss biochemist, Paul Hermann Muller, discovered its potency as an all-purpose insecticide. For that discovery, Müller was awarded the Nobel Prize in 1948.

Before the introduction of DDT, insect-borne diseases like malaria, typhus, yellow fever, and bubonic plague killed untold millions of people worldwide. During World War II, use of DDT became common among American troops who needed it to control these illnesses.

After World War II, the use of DDT expanded, as farmers discovered its effectiveness in controlling agricultural pests, and DDT became the weapon of choice in anti-malaria efforts.

However, it was discovered that its harmful effects were not limited to insects, but extended to human beings too. Today, its use is banned in many countries.

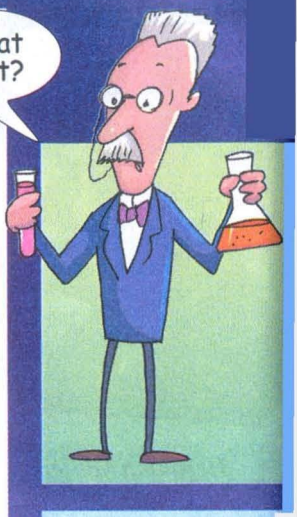
Le Chatelier

How did Le Chatelier Principle change the chemical industry?

Le Chatelier was a French chemist who was interested in organizing the relationship between science and industrial production.

He developed a principle that makes it possible to predict how a change in conditions such as temperature, pressure etc will affect chemical reactions. This principle proved to be of immense value to the chemical industry, as it helped in developing the most efficient chemical processes.

In almost all cases, chemical reactions do not result in 100 per cent of the reactants becoming turned into products. When running a largescale chemical reaction, maximizing yield is paramount to profit, and this is where Le Chatelier's principle proved so useful.



Arrhenius Theory

The Arrhenius Theory was introduced in 1887 by a Swedish chemist, Arrhenius. It proved to be a landmark in acid chemistry. The theory classifies substances as either acids or bases.

Atomic Numbers

You will study about the atomic number in both chemistry and physics. The atomic number is the number of protons found in the nucleus of an atom. Today, elements are identified by their atomic numbers.

Who discovered canal Rays?

Canal Rays, called positive rays, are positively charged ions that are accelerated toward, and through a perforated cathode in an evacuated tube.

The first ideas about electrons came from experiments with cathode ray tube. A typical cathode ray tube is a partially evacuated glass tube with a piece of metal sealed at each end. The pieces of metal are called electrodes- the one given a negative charge is called the cathode, and the one given a positive charge is the anode.

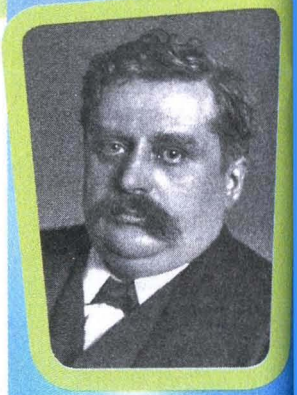
If a high electrical voltage is applied to the electrodes, an electrical discharge can be created between them. This discharge appears to be a stream of particles emanating from the cathode.

A special type of cathode ray tube produces canal rays. The cathode is perforated, and the tube contains a gas at very low pressure. Experiments on canal rays were begun in 1886 by E. Goldstein.

Why is the birth of coordination chemistry so important?

The term coordination chemistry is generally used to describe the chemistry of a special type of compounds containing a metal atom surrounded by atoms or group of atoms. These compounds are known as coordination compounds. Experimental observations as early as in the middle of 18th century reported the isolation of coordination compounds.

Coordination chemistry is considered to have begun with the works of the French chemist B.M. Tassaert in 1798. However, the field gained prominence after the works of Alfred Werner on such compounds. He received the Nobel Prize in 1913 for his work on coordination compounds. Coordination chemistry thus became an important branch of chemistry.



Alfred Werner

Why is William Ramsay's work important?

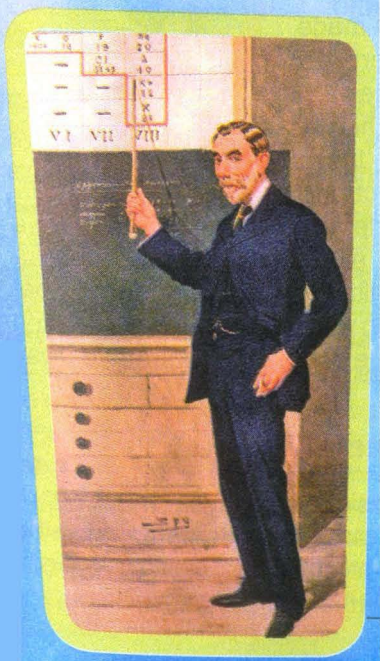
William Ramsay was a British physical chemist who discovered four gases. They are neon, argon, krypton, and xenon.

Ramsay devised an experiment designed to strip away all of the known components of air. Whatever was left must be the mysterious unknown element.

What Ramsay found was very strange indeed- a new gas with its very own weight and properties, which did not seem to do anything, or to react with any of the other elements. He named it argon, or the lazy gas.

It was the first of four inert gases he would discover, forming the basis of an entire new group of elements.

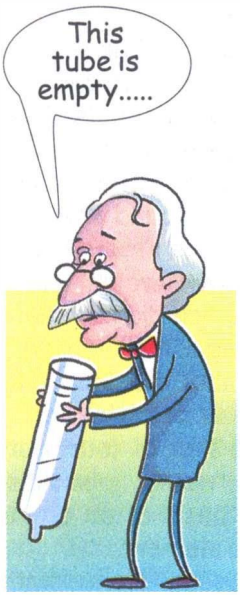
These gases, along with helium and radon, were called the noble gases. They eventually added an extra column to the periodic table,and Ramsay won the Nobel Prize for Chemistry in 1904 for his work.



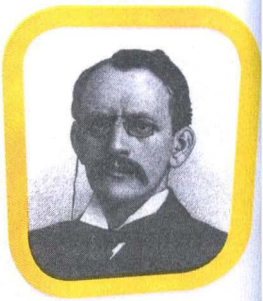
William Ramsay

Why is J.J. Thomson's discovery of the electron important?

J.J. Thomson was an English scientist who discovered electron. Thomson made this discovery through his cathode ray experiments. He produced cathode rays by firing electrical currents through glass pipes filled with low-density gas.

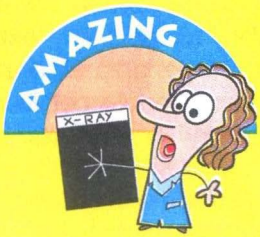


He deduced from his experiments that the current inside the cathode ray tube was made of tiny particles which carried a negative charge. He named these particles 'electrons'.



J.J. Thomson

Thomson deduced that electrons were a basic part of all atoms. Two other conclusions were also drawn. The first was that since electron was negatively charged, and atoms are electrically neutral, it was



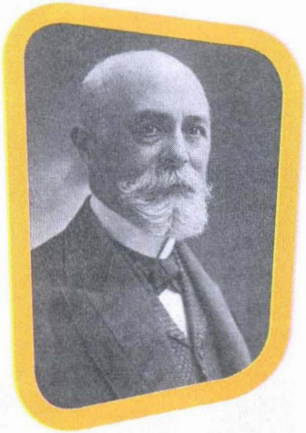
Really, Really Tiny

Some atoms contain many electrons. Yet, the total mass of the electrons in an atom is never so much as one thousanth of the atom, which makes them really, really tiny!

concluded there must be a positive charge somewhere in the atom.

The second conclusion was that because electrons are so much smaller than atoms, there must be other, more massive particles in the atom.

Thomson's discovery, made in 1897, is of great importance because it showed us that atom can be split into smaller parts. In 1906, Thomson received the Nobel Prize for his discovery of the electron.



Henri Becquerel

Why did the discovery of radioactivity change concepts of atomic structure?

In 1896, Antoine Henri Becquerel, a French scientist, was conducting an experiment which started with the exposure of a uranium-bearing crystal to sunlight.

Becquerel had accidentally discovered that a piece of mineral which contained uranium could produce its image on a photographic plate in the absence of light, a phenomenon that we now know as radioactivity.

Radioactivity was to become an important tool in studying the structure of the atom. It forced scientists to radically change their ideas about atomic structure, for it demonstrated that the atom was neither indivisible nor immutable.

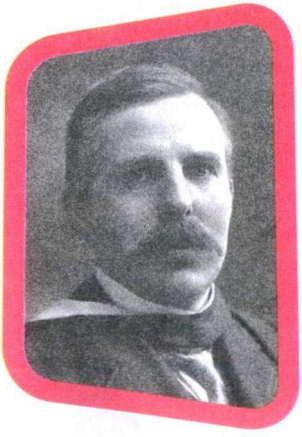
Mass Number

The term mass number refers to the total number of protons and neutrons that are found in a single nucleus.

Marie Curie and Pierre Curie

Why are Pierre and Marie Curie considered to be an extraordinary couple?

Pierre and Marie Curie were an extraordinary couple- and were both extraordinary scientists too. They married in 1895, and were awarded the Nobel Prize for Physics in 1903



Ernest Rutherford

Why are the works of Rutherford important in the history of chemistry?

Ernest Rutherford was a New Zealand chemist who made numerous contributions to science.

Rutherford worked on radioactivity coining the terms 'alpha' and 'beta' to describe the two different types o

for their joint research on radiation.

After French physicist Henri Becquerel first discovered a strange source of energy coming from uranium, Marie Curie decided that this would make a good field for research. Pierre and Marie came up with the term 'radioactivity' to describe the spontaneous emissions that they studied.

Marie discovered two new elements which the Curies named 'radium' -after 'radiation-and Polonium' -after Poland.

In 1903, the Curies and Henri Becquerel received the Nobel Prize for their combined research and discoveries on radioactivity. In 1911, Marie Curie was honoured with a second Nobel Prize, this time in chemistry, to honour her for successfully isolating pure radium and determining radium's atomic weight.

radiation emitted by uranium and thorium.

He also observed that radioactive material took the same amount of time for half of it to decay- this became known as its 'half life'.

In 1907, Rutherford, and two other scientists, Hans Geiger and Ernest Marsden, carried out an experiment to examine the structure of the atom. The results of the experiment were used to create the Rutherford model of the atom.

The model showed electrons circling around the nucleus like planets orbiting the sun. In 1908, Rutherford was awarded the Nobel Prize in Chemistry.

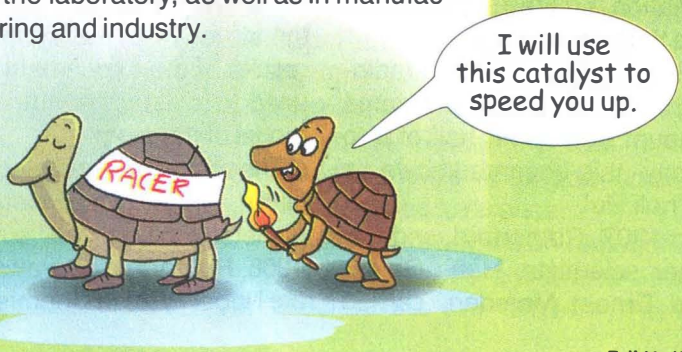
Why are catalysts important in chemistry?

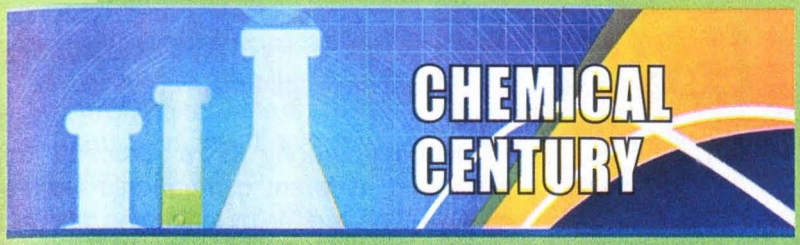
A catalyst is a substance that speeds up, or slows down a reaction, but is unaffected by it.

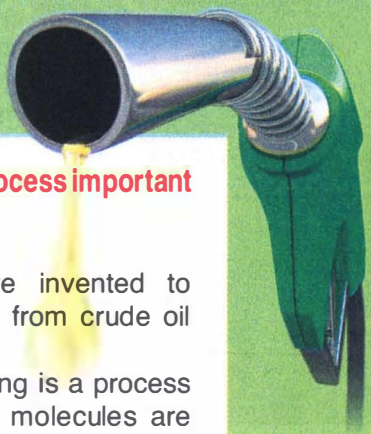
The process by which this substance speeds up or slows down a reaction is called catalysis. Catalysts are important, because without their help, the amount of energy needed to spark a particular reaction would be higher. In fact, without the help of catalysts, some chemical reactions might never occur.

When the chemical reaction occurs, the catalyst itself is not changed and is not part of the end result. Most times, it can be reused over and over in subsequent reactions

Sometimes, instead of accelerating a reaction, a catalyst works to slow a reaction. Such catalysts are known as inhibitors. Catalysts are also important in the laboratory, as well as in manufacturing and industry.







Why is the thermal cracking process important in the petroleum industry?

The processes that were invented to improve the yield of gasoline from crude oil were known as cracking.

In petroleum refining, cracking is a process by which heavy hydrocarbon molecules are broken up into lighter molecules. Thermal cracking is a refining process in which heat and pressure are used to break down, rearrange, or combine the hydrocarbon molecules.

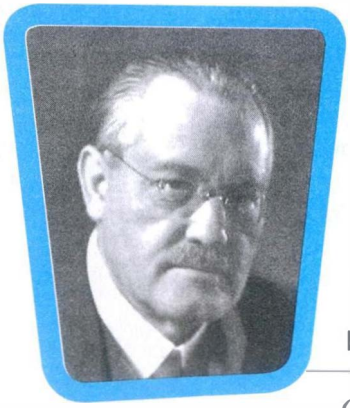
The first thermal cracking process was developed around 1913.It was invented by William Merriam Burton. However, this claim was disputed by the Russian scientist Vladimir Shukhov who had patented a process for thermal cracking as early as 1891 in Russia.

Cracking is one of the principal ways in which crude oil is converted into useful fuels such as motor gasoline, jet fuel, and home heating oil.

Why is the discovery of chromatography a significant development in chemistry?

Chromatography is a process for separating different components from a mixture. This is done by letting the mixture, which is in gas or liquid form, creep slowly past another substance, which is typically a liquid or solid.

The moving substance is called the mobile phase and the substance that stays put is the stationary phase. As the mobile phase moves, it separates out into its components on the stationary phase, and we can then identify the components one by one.



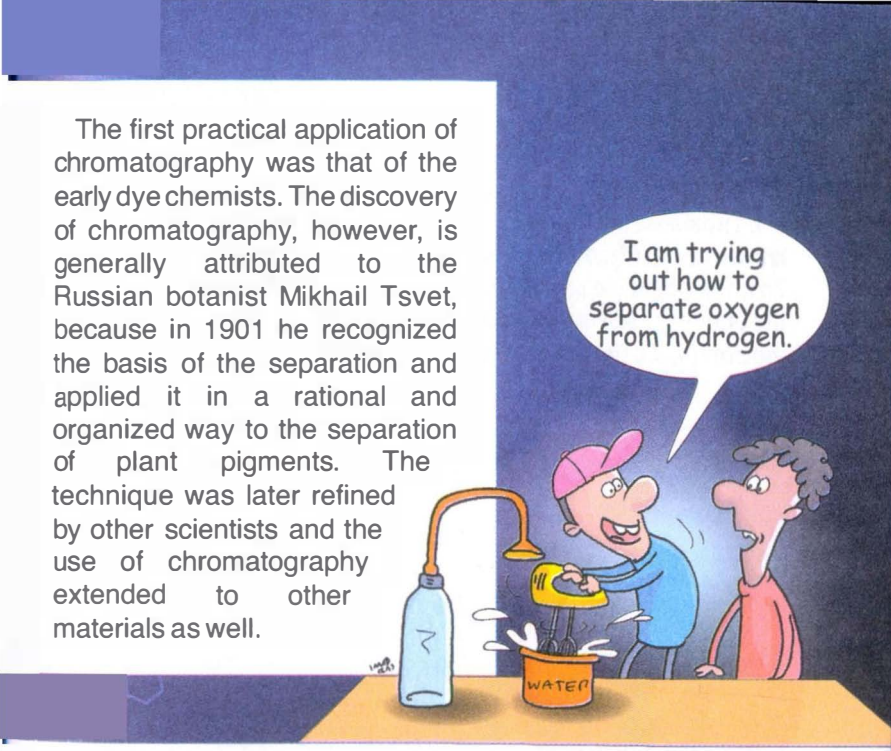
Carl Bosch

What is the role of the Haber process in the chemical industry?

The Haber process is a process that is used to produce ammonia from nitrogen and hydrogen, using iron as a catalyst.

The process was developed by Fritz Haber and Carl Bosch in 1909. It was first used on an industrial scale by the Germans during World War I.

The first practical application of chromatography was that of the early dye chemists. The discovery of chromatography, however, is generally attributed to the Russian botanist Mikhail Tsvet, because in 1901 he recognized the basis of the separation and applied it in a rational and organized way to the separation of plant pigments. The technique was later refined by other scientists and the use of chromatography extended to other materials as well.



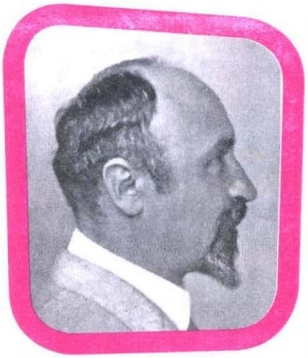
The Haber process has played a pivotal role in the chemical industry as a whole, because the fertilizer generated from ammonia is responsible for sustaining one third of the Earth's population, and at the same time ammonia is hard to produce on an industrial scale.

The Haber process changed all that, and made ammonia affordable. Haber and Bosch were later awarded Nobel prizes, in 1918 and 1931.

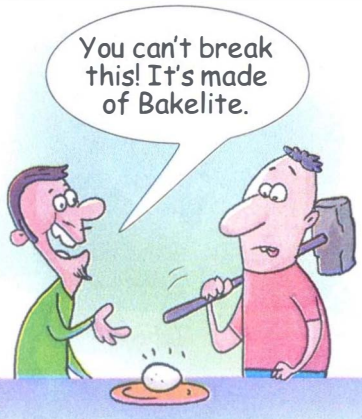
Fritz Haber

Plum Pudding Model

The Plum Pudding Model is an atom model proposed by J.J. Thomson, the physicist who discovered electron. It is also known as the Chocolate Chip Cookie or Blueberry Muffin Model. To understand the comparison, imagine a plum pudding where in the pudding itself is positively charged, and the plums, dotting the dough, are the negatively charged electrons.



Leo Baekeland



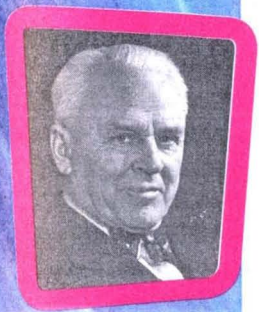
Why did the invention of bakelite usher in a new era in chemistry?

In 1909, a chemist named Leo Baekeland synthesized bakelite, the first truly synthetic plastic from a mixture of phenol and formaldehyde.

He had started to create a substitute for shellac, and ended up creating an original form of plastic that he called Bakelite.Bakelite can be moulded when hot, and solidified into a hard plastic that can be used for handles, phones, auto parts, and furniture. Bakelite is hard, and is resistant to heat and electricity.

Baekeland prophesied that plastic would be one of the world's most useful resource, and his prophecy came true. The invention of Bakelite also led to a whole class of plastics with similar properties, known as phenolic resins.

Millikan's Oil Drop Apparatus



Robert Millikan

What was Millikan's Oil Drop Experiment?

Between 1909 and 1910, the American physicist Robert Millikan conducted a series of experiments to measure the charge of an electron.

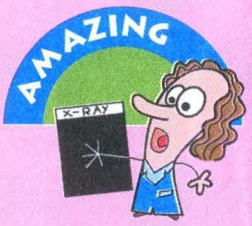
These were known as oil-drop experiments. Basically, Millikan found a way to attach electrons to small droplets of oil, and then measure their response to an electric field. By comparing applied electric force with changes in the motion of the oil drops, Millikan was able to determine the electric charge on each drop.

Millikan found that all of the drops that had charges that were simple multiples of a single number which was the fundamental charge of the electron. Millikan won the Nobel Prize in Physics in 1923 for his studies in this field.

What did Rutherford's gold foil experiment prove?

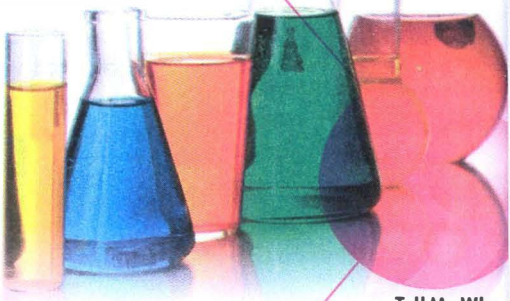
The size of the atom is about ten billionths of an inch – and in 1911, the New Zealand–born British physicist Ernest Rutherford discovered that at the centre of the atom, lurked a positive centre about 100,000 times smaller. He called it the nucleus.

It was Rutherford's gold foil experiment that triggered this discovery. When Rutherford shot a beam of alpha particles at a sheet of gold foil, a few of the particles were deflected. He concluded that a tiny, dense nucleus was causing the deflections. The experiment proved that there is a small, dense, positively charged core or nucleus surrounded by mostly empty space, and very small, negatively charged electrons. Thus, the gold foil experiment resulted in a new model of the atom.



Invisible Planets

A scientist, Niels Bohr, compared the atom to the solar system. The nucleus would be Sun, and the tiny electrons orbiting the nucleus are like planets orbiting the Sun.



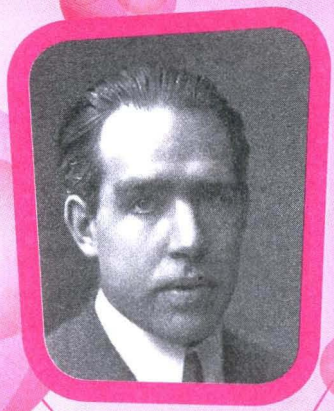
What is the significance of Niels Bohr's work?

Niels Bohr was a Danish Nobel Prize winning scientist, who made extremely important contributions to the fields of atomic structure and quantum mechanics.

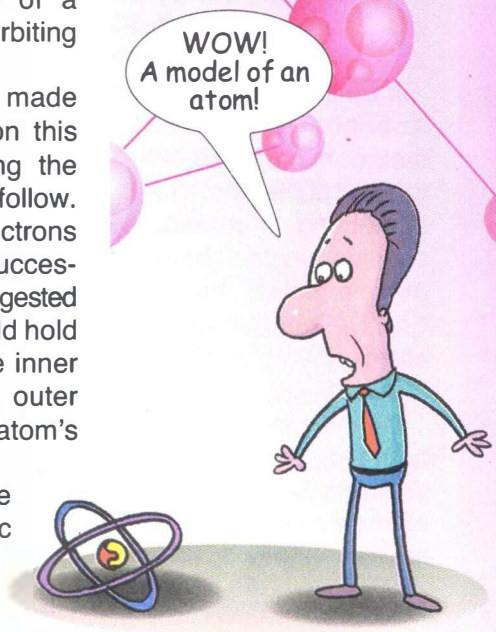
Bohr's most well-known and important contribution was his work on the theory of the structure of the atomic model. His mentor, Ernest Rutherford, had already theorized that atoms were made up of a nucleus, with electrons orbiting it.

However, Bohr made important expansions on this theory, mainly regarding the paths that the electrons follow. He proposed that electrons travel only in certain successively larger orbits. He suggested that the outer orbits could hold more electrons than the inner ones, and that these outer orbits determine the atom's chemical properties.

He won the Nobel Prize in 1922 for his atomic model.



Niels Bohr



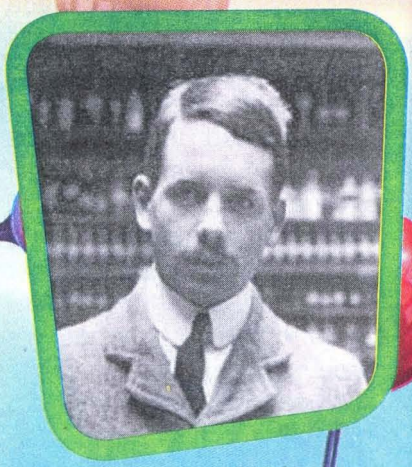
Why was Henry Moseley's work on the atomic number an important step forward in chemistry?

The atomic number represents the number of protons that are found in the nucleus of an atom.

The nucleus is the heart of the atom, and it contains one or more protons, each having a positive electrical charge.

It was Henry Moseley, an English scientist, who first demonstrated that the nucleus had something in it with a positive electric charge, and referred to this positive charge as the atomic number of that element.

Moseley's discoveries resulted in a more accurate positioning of elements in the periodic table.



Henry Moseley

Why was the discovery of isotopes an important one?

Frederick Soddy

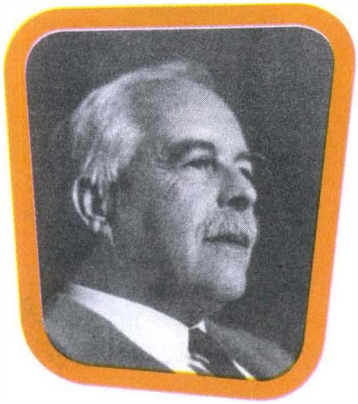
Atoms are made up of protons, electrons, and neutrons. An atom of an element that is either missing a neutron, or has an extra one, is called an isotope.

Isotopes of an element are still the same element. It was the English chemist Frederick Soddy who proposed in 1912, that the same elements exist in different forms, with nuclei having the same number of protons, but different numbers of neutrons. As an example, uranium-235 and uranium-238 are two different isotopes of the same element. There are 92 protons and 143 neutrons present in uranium-235. But in uranium- 238, number of neutrons are 146.

Soddy's discovery of isotopes was very important, because today, they have a wide variety of uses in medicine, and are also used to determine the age of fossils. Their most important use is in the field of nuclear energy.

Good Creator

Glen Seaborg was an American atomic scientist. He is famous for being the co-creator of 10 new elements in a nuclear reactor. The element seaborgium was named for him in honour of his accomplishments. For the remainder of his life, Seaborg was the only person in the world who could write his address in chemical elements- Seaborgium, Lawrencium, Berkelium, Californium, Americium, standing for Seaborg, Lawrence Laboratory, Berkeley, California, United States of America!



Gilbert Lewis

Why is Gilbert N. Lewis one of the giants of chemistry?

Gilbert Lewis is considered one of the giants of chemistry for his work that gave us greater insights into the atom.

He observed that atoms with a specified number of electrons in their outer layer are very stable, and that atoms will share, or transfer electrons with other atoms to achieve stability. This sharing

Missing Prize

Unfortunately, Lewis never received the Nobel Prize for his magnificent contributions. It is thought that if he had lived longer, he would have shared the 1954 Nobel Prize inChemistry with Pauling for his contributions to the theory of the chemical bond.

Why did Louis de Broglie's ideas start a wave in chemistry?

In 1923, Louis de Broglie, a French scientist, suggested that all matter has wave - like nature, and will exhibit wave- like properties. This proved to be one of the milestones in chemistry.

According to De Broglie, electrons could act as both particles and waves. De Broglie's hypothesis was soon confirmed in experiments that showed electron beams could be diffracted or bent, as they passed through a slit, much like light could.

When the French Academy became aware of his theory of

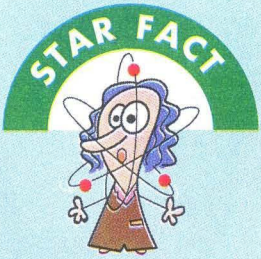
or transferring of electrons is called chemical bonding, and it explains how chemical compounds are formed.

Lewis published several influential works on chemical bonding. He gave the name 'photon' for the smallest unit of radiant energy in 1926.

Lewis produced a pure sample of deuterium oxide- also called heavy water- in 1933. Heavy water is used in certain types of nuclear reactors.

Louis de Broglie

electron waves, it caught Albert Einstein's attention, and he had high praise for Broglie's bold ideas. His ideas inspired the birth of wave mechanics.

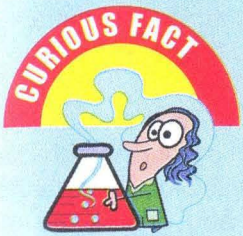


Microscopic Uncertainty

In the world of atoms, things are so small that light waves bouncing off atoms causes them to change direction and speed, and in some cases, even knock the electrons in the atom away from the atom. No matter what these microscopic particles collide with - light, other little particles, air molecules - it always changes the position or speed of that particle. This makes it impossible to accurately measure the speed and position of subatomic particles like electrons at the same time. We say we can only measure speed and position within a certain range, or within a certain uncertainty. This is called the Heisenberg Uncertainty Prin ciple.

Why is Erwin Schrodinger remembered to this day?

Erwin Schrodinger created a powerful model for the atom in 1926. He assumed that the electron is a wave, and tried to describe where electrons are most likely to be found. His model does not tell us where an electron is- only where it might be. Schrodinger's wave equation is one of the most basic equations of quantum mechanics. He provided a line of thought to scientists that



Quantum Chemistry

Quantum chemistry is the application of quantum mechanics to problems in chemistry. It involves the use of both experimental and theoretical methods. Fritz London and Walter Heitler ushered in the era of quantum chemistry with their work in which they applied quantum mechanics to explain bonding in a hydrogen molecule.

Erwin Schrodinger

would become accepted, and incorporated it into thousands of papers, thus becoming the cornerstone of quantum theory. He is famous for the 'Schodinger Cat Theory,' that centred on a cat in a box with a vial of poison. The box is sealed and the vial had a 50 per cent chance of breaking and killing the cat. Equally, the cat had a 50 per cent chance of being fine. But if we don't open the box, the cat is simultaneously both alive and dead. He used this theory to try and explain quantum mechanics- but if you don't understand it now, don't worry. You will, when you are older! Schrodinger shared the 1933 Nobel Prize in physics with the British Physicist P.A.M. Dirac.

Linus Pauling

Chemistry and Peace

Pauling was awarded the Nobel Prize for Chemistry in 1954, and in 1962, the Nobel Peace Prize. He is the only person to have won two unshared Nobel Prizes, and one of the four people who have won more than one Nobel Prize. Only one other person – Marie Curie- has won Nobel Prizes in two different fields.

Why is Linus Pauling considered one of the most influential chemists in history?

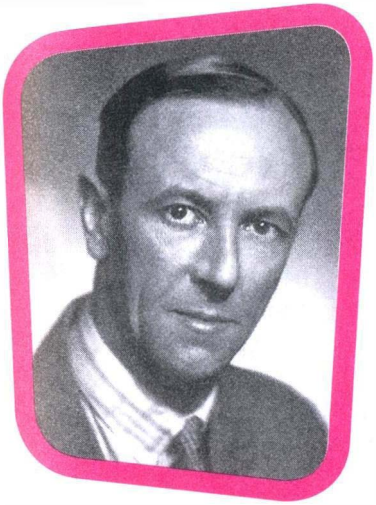
Linus Pauling, an American, was one of the founders of the fields of molecular biology and quantum chemistry, and one of the most influential chemists in history.

He made a mark in the world of chemistry with his use of X-rays to examine the molecular structure of crystals. This work led him to a more thorough investigation of the nature of the chemical bond.

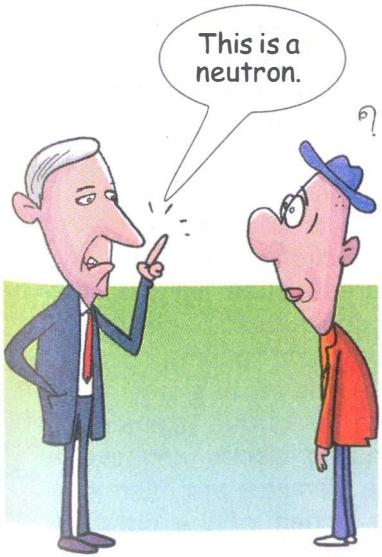
Pauling revolutionized chemistry in the 1920s with his application of quantum physics to the study of chemistry. He used the new theory of wave mechanics to explain molecular structures, which had baffled chemists for years.

Pauling's resonance theory proposed that some molecules 'resonate' between different structures, rather than holding a single fixed structure.

Linus Pauling won two undivided Nobel Prizes. In 1954, he won the Prize for chemistry. Eight years later, he was awarded the Peace Prize for his opposition to weapons of mass destruction.



James Chadwick



Why was the discovery of neutron a groundbreaking one?

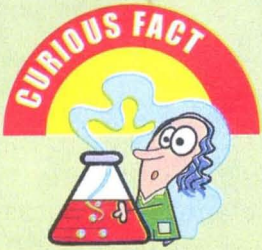
It was James Chadwick, an English scientist, who discovered a particle in the nucleus of an atom that became known as neutron because it has no electrical charge.

In 1919, Rutherford had discovered proton, a positively charged particle within the atom's nucleus. But researchers were finding that proton did not seem to be the only particle in the nucleus.

Chadwick's experiments proved that another particle, neutron, did exist. He published his findings entitled 'Possible Existence of Neutron.' In 1935, he received the Nobel Prize for his discovery.

This new idea dramatically changed the picture of the atom, and scientists found that neutron made an ideal 'bullet' for bombarding other nuclei.

Before long, neutron bombardment was applied to uranium atom, splitting its nucleus and releasing huge amounts of nuclear energy.



Nuclear Man

Rutherford is often called 'The First Nuclear Scientist', because he showed that atoms had a positively charged nucleus with negatively charged electrons whizzing around it.

What is the electronegativity scale?

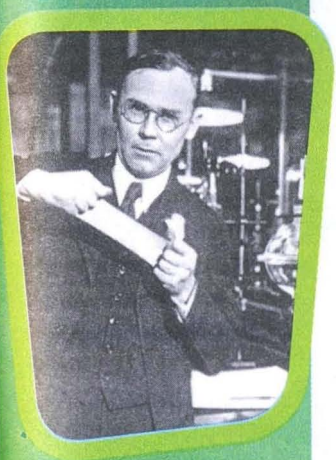
Electronegativity is a chemical property of an element that describes the tendency of an atom to attract electrons of a bond. The higher the electronegativity, the greater will be an atom's attraction for electrons.

The most electronegative element is fluorine, followed by oxygen, chlorine, and nitrogen. The discovery of electronegativity scale was one of Linus Pauling's important contributions to chemistry.

He assigned fluorine's electronegativity as four, and then calculated the electronegativities of other elements relative to this number. Lithium, at the other end of the same period on the periodic table, is assigned a value of one.

Electronegativity generally increases from left to right on the periodic table, and decreases from top to bottom.

Metals are the least electronegative of the elements. The Pauling electro negativities for the elements are often included as a part of the chart of the elements.



Wallace Carothers

Why is Wallace Carothers associated with man-made polymers?

Polymers are substances made up of many, many molecules all strung together to form really long chains. They are organic chains formed through the linkage of many identical molecules called monomers.

Polymers can be natural, like those that make up the trunk of a tree or a chunk of rock, or they can be man-made.

Wallace Carothers is the person re sponsible for inventing the man-made polymers, nylon and neoprene. He worked for the Du Pont Company, and his team was the first to investigate the acetylene family of chemicals.

In 1931, he started to manufacture neoprene, a synthetic rubber created by his laboratory. By 1934, Wallace Carothers had made significant steps toward creating a synthetic fabric. He combined different chemicals to create a new fibre using what is known as a polymerizing process. He patented this new fibre and called it nylon. Nylon was considered to be a miracle fabric, and was the first completely new synthetic fibre made by Man.

Which was the first artificially created element?

The first artificially created element was technetium(Tc). It was created in 1937 by Emilio Segre and Carlo Perrier. The researchers found it in a sample of molybdenum.

The sample was bombarded by deuterium nuclei in which gave them the isotope Tc-97. Technetium is a silvery-gray metal that slowly tarnishes in moist air.

Scientists believed that this new element does not occur in nature. However, in 1988, minute quantities of it were found in an ore from a deep molybdenum mine in Colorado, USA.

Technetium is chemically active and useful in that it forms oxides, sulfides, and technetiates. Compounds and alloys containing technetium oxide can prevent the corrosion of iron by water.

Technetium-99 is used for radioactive tracing in medicine.

Emilio Segre

Carlo Perrier

When was Freon discovered?

Freon is the first chlorofluorocarbon or CFC. Do you know what CFC is? CFCs are compounds containing the elements carbon and fluorine, and, in many cases, bromine, chlorine and hydrogen.

Freons are colourless, odourless, nonflammable, noncorrosive gases or liquids. Freon was discovered by Thomas Midgely, an American engineer. He was looking for a new coolant for refrigerators to replace the gases ammonia and sulphur dioxide that were then being used.

These two gases are highly poisonous, and have a terrible odour too, so there was a need to find a substitute. A collaborative effort began between three American corporations Frigidaire, General Motors, and DuPont to search for a less dangerous method of refrigeration. And Freon was discovered.

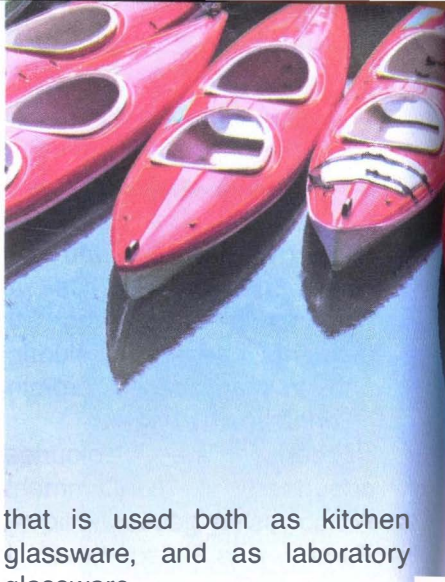
Thomas Midgely

Which are some of the useful materials developed in the 20th century?

Fibreglass, pyrex, and synthetic rubber are just some of the useful materials developed in the 20th century. Polymer chemistry also was developed during this time.

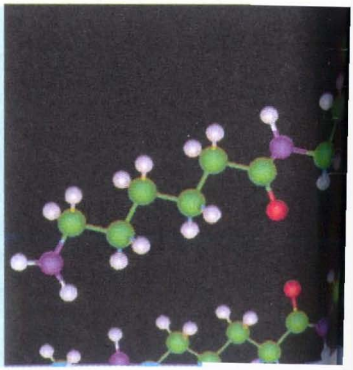
Fibreglass was developed in the 1930s by an American, Games Slayter. It is a light-weight, extremely strong, and robust material. It is used for insulation, and also used in high performance aircraft, boats, automobiles, water tanks, and surfboards.

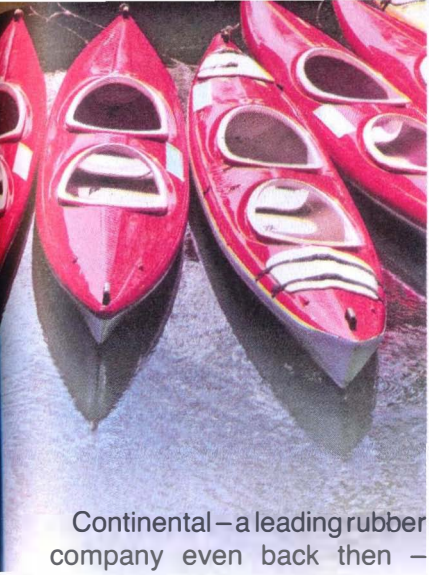
Pyrex, developed in 1915 by Corning, is a heat resistant and shock resistant glass that is used both as kitchen glassware, and as laboratory glassware.



Another important development was that of synthetic rubber. In 1909, the chemist Fritz Hofmann succeeded in producing the elastic substance methyl-isoprene, thus paving the way for the development of synthetic rubber.

Hermann Staudinger

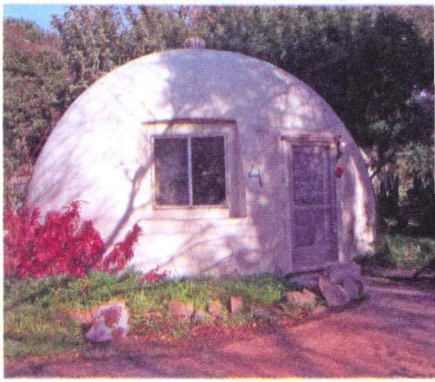


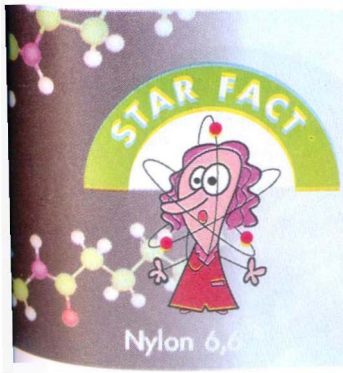


Continental – a leading rubber company even back then – started to produce the first car tyres from this new material as early as 1910. The advances made in synthetic rubber during World War II coincided with advances made in the larger sphere of polymer chemistry, of which rubber is one part.

Leo Baekeland created the polymer Bakelite, a completely synthetic polymer. Other synthetic polymer advances included neoprene, the first synthetic rubber, in 1930, and nylon, the famed polymer fibre invented in 1935.

A Fibreglass Dome House





Father of Polymer Chemistry

The German chemist, Hermann Staudinger, is considered to be the father of polymer chemistry. It was his studies on rubber that led him to suggest that it was made up of strand-like molecules or polymers. He won the Nobel Prize in Chemistry in 1953.

Who first seperated heavy water?

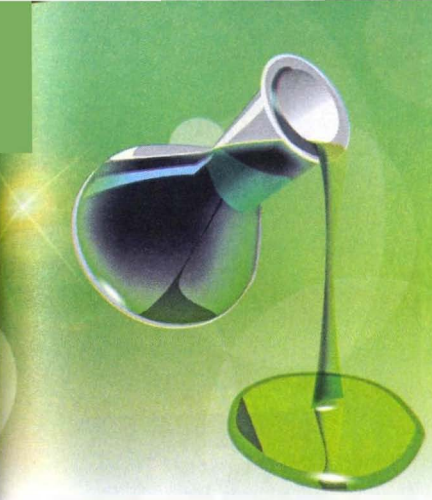
Gilbert Newton Lewis, an American chemist, was the first to separate heavy water from ordinary water. Heavy water, also known as deuterium oxide, is similar to ordinary water, but instead of two hydrogen atoms, each molecule contains two atoms of deuterium, an isotope of hydrogen. This makes each molecule 10 percent heavier than an ordinary water molecule.

Heavy water behaves in a slightly different manner from ordinary water. In every 7,000 parts of ordinary water, there is one part heavy water. Heavy water was first discovered by Harold Urey, who received a Nobel Prize for his discovery. However, it was Gilbert Lewis who first separated it from ordinary water. Heavy water is used to run nuclear reactors and for agricultural purposes.

Harold Urey

Artificial Diamond

The first artificial diamond was made in 1955. It was developed by Tracy Hall, a scientist at the General Electric Company in the USA.



Paul Heroult

How did steel and aluminium become a part of our daily lives?

When iron is heated to very high temperatures, it starts to absorb carbon rapidly, and to melt. In 1872, an English company named Woods and Clark patented an alloy of iron, chromium and tungsten, that was resistant to acid, and to weather. This was probably the very first form of steel.

However, stainless steel as we know it today, was developed only in 1913 by Harry Brearley as he was attempting to find erosion-resistant steel. Stainless steel is a part of our daily lives now as it has a wide range of uses, from cutlery to weapons.

Aluminium was discovered in the 19th century, but its extraction and production were very expensive.

Harry Brearley

Charles Martin Hall

This changed with the use of electricity for extraction, and aluminium became a lighter alternative to steel and copper.

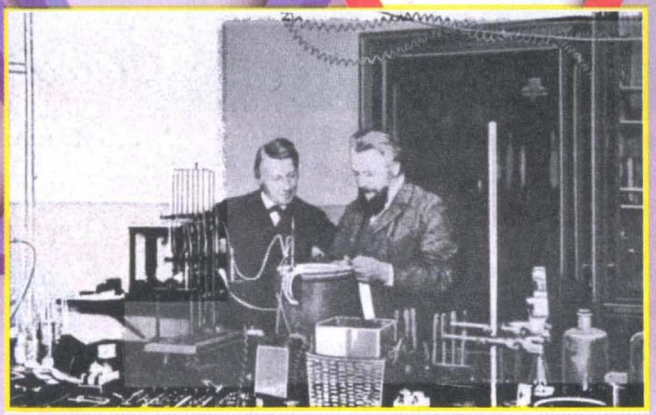
Paul Louis Toussaint Héroult of France, and Charles Martin Hall of the USA both came up with a process of dissolving aluminium oxide in molten cryolite and passing it through a large electrical current. When this was done, pure aluminium collected at the bottom. The process was named after both scientists.

Today, aluminium is widely used in household appliances, in the electricity industry, in buildings, and for aircraft construction.

Wilhelm Ostwald

When were artificial fertilizers first used?

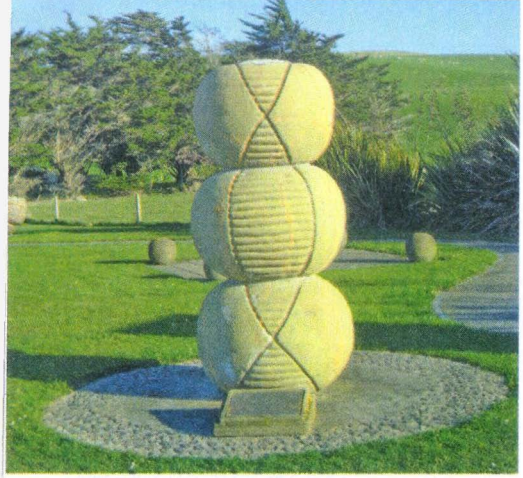
Fertilizers have always played an important role in boosting agricultural production, but farmers used to depend on natural fertilizers like manure and leaf mould to provide nutrition for plants.



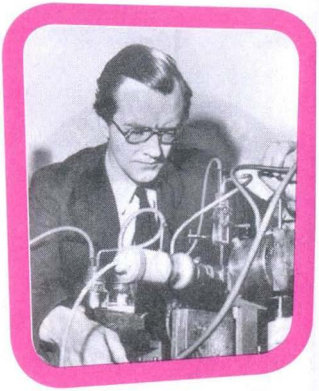
Jacob Van't Hoff and Wilhelm Ostwald

In 1908, Wilhelm Ostwald, a German chemist, invented the process to manufacture nitric acid which can be used as a base for nitrogenous fertilizers. Later, a chemist named Fritz Haber developed a method of synthesizing ammonia, which is used in fertilizers. He was awarded the 1918 Nobel Prize in chemistry for this discovery.

The use of artificial fertilizers gave a tremendous boost to agricultural production. Their increasing popularity also triggered a spurtinchemicalengineering and the production of inorganic and organic chemicals, petrochemicals, agrochemicals, and explosives.



Monument to Maurice Wilkins

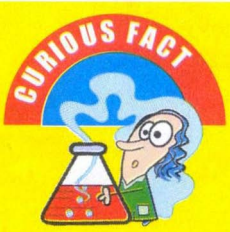


Maurice Wilkins

Why is Maurice Wilkins is considered a great scientist?

Maurice Wilkins was a New Zealand born scientist who worked on the separation of uranium isotopes for use in the atomic bomb. He came to Britain, and began a series of investigations that led ultimately to his studies of DNA. His X-ray diffraction studies of DNA proved crucial to the determination of DNA's molecular structure by James Watson and Francis Crick.

This discovery had far-reaching consequences. Now that the structure of DNA was understood, scientists could understand the method by which the genes of the parent are passed down to the child.



World of Elements

There are 118 elements in the periodic table. Uranium, with atomic number 92, is the heaviest natural element. Last year, scientists confirmed the discovery of element with atomic number 115.

Fritz Strassmann

Otto Hahn

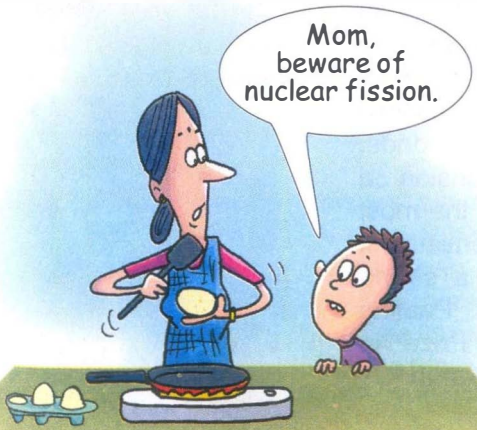
Who discovered nuclear fission?

When an atom splits into two, it releases energy. This process is known as fission. In other words, nuclear fission is a nuclear reaction in which a massive nucleus splits into smaller nuclei, with the simultaneous release of energy.

In 1938, German physicists Otto Hahn and Fritz Strassmann bombarded a uranium atom with neutrons in an attempt to make heavy elements. In a surprising twist, they wound up splitting the atom into the elements of barium and krypton.

It was Austrian-born physicist Lise Meitner, who realized that the split had also released energy and new neutrons. Ultimately, other physicists realized that each newly freed neutron causes further fissions, and it led to a chain reaction.

This discovery had a tremendous impact on the development of nuclear energy, both for peaceful and military purposes.

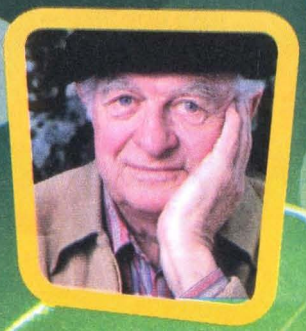


Why did 'The Nature of the Chemical Bond' have a great impact on the world of chemistry?

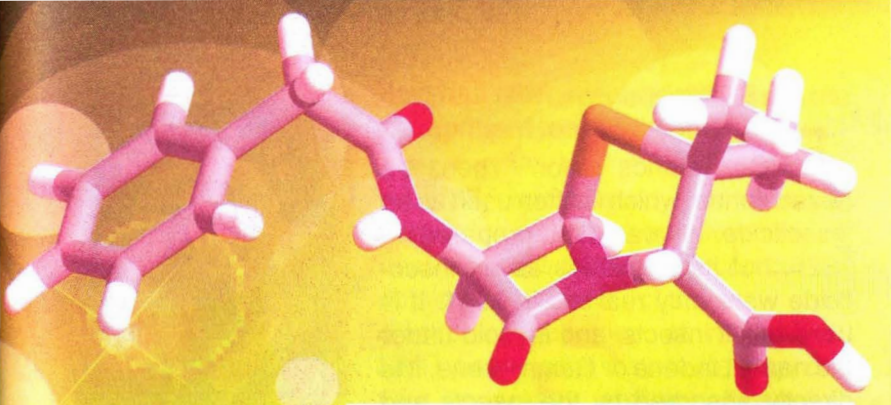
In 1926, Linus Pauling, then a promising young scientist, set sail for Europe to study quantum mechanics with an eye toward applying this new physics to problems in structural chemistry. Pauling's ensuing programme of research would result in a remarkable book, 'The Nature of the Chemical Bond' that revolutionized the scientific world's conception of how atoms join together to form molecules.

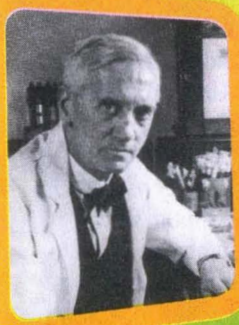
Chemical bonds are formed when the electrons in an atom interact with the electrons in another atom. This allows for the formation of molecules. In a sense, all of chemistry is possible only because of chemical bonds.

Pauling's work is considered by many scientists as the most influential work in chemistry. It placed chemistry on a strong theoretical footing. Pauling received the Nobel Prize in chemistry in 1954 for this work.



Linus Pauling





Alexander Fleming

Why did Alexander Fleming start a revolution in antibiotics?

Alexander Fleming was the scientist who revolutionized medicine with his discovery of penicillin. In 1928, while studying influenza, Fleming noticed that a mould had developed accidentally on a set of culture dishes being used to grow the staphylococci germ. The mould had created a bacteria-free circle around itself. Fleming experimented further, and named the active substance penicillin.

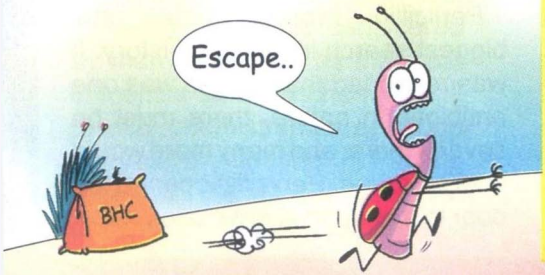
Penicillin brought about the biggest search in medical history. It was reasoned that if there was one antibiotic in nature, there must be several more, and many more would later be found. Penicillin opened the door to the world of antibiotics.

What is BHC?

BHC stands for benzene hexachloride, which is often used as an insecticide. It was first prepared in 1825, but its properties as an insecticide were only realized in 1944. It is used to kill insects, and is sold under the name Lindane or Gammexene. It is directly absorbed by the insects and their eggs, and kills on contact.

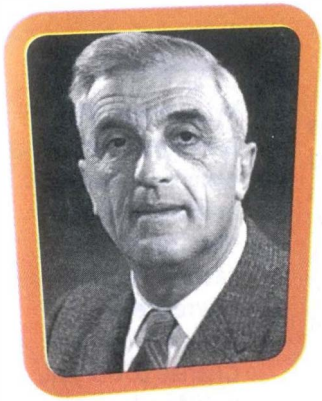
Lindane was first produced for commercial use in the United States in 1950. It was used in agriculture as a spray for foliage, to treat soil and seed grains, and in baits for rodent pests. Lindane can kill a broad range of insects, including worms that eat leaves, insects that live in the soil, and human and animal parasites, such as fleas, ticks, and lice.

Today, the use of Lindane has been restricted due to concerns over its potential to cause cancer and birth defects in animals.

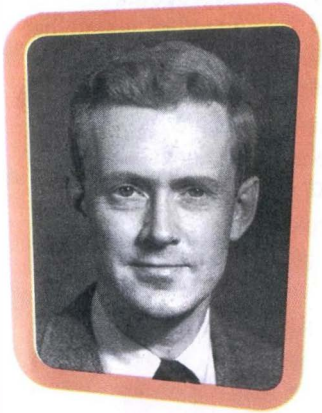


Neptunium

Neptunium was discovered by McMillan and Abelson in 1940 at Berkeley, California, USA. They bombarded uranium with neutrons produced from a cyclotron. It was the first synthetic transuranium element discovered. Transuranium elements are elements, that come after uranium on the periodic table. Neptunium was named after the planet Neptune.



Felix Bloch



Edward Mills Purcell

How has NMR spectroscopy become an important tool in chemistry?

NMR spectroscopy or nuclear magnetic resonance spectroscopy is used as a spectroscopic technique to obtain physical, chemical, and electronic properties of molecules. NMR uses radio waves to map out your body parts, and is not harmful. NMR spectroscopy is based on the magnetic properties of an atom. Using this technique, a scientist can determine molecular structure.

Felix Bloch and Edward Mills Purcell are two names associated with NMR spectroscopy. However, it was Robert Ernst who developed techniques for high resolution NMR spectroscopy that made NMR a basic tool for analytical chemistry.

NMR Apparatus

Why is the development of radiocarbon dating considered a historic event?

Radiocarbon dating is a technique used by scientists to find out how old ancient fossils and artefacts are. It was developed by Williard Libby in 1947. Libby won the Noble Prize in chemistry in 1960 for this historic discovery.

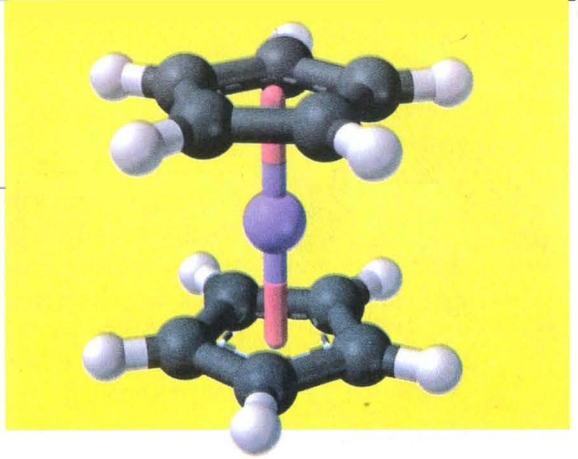
All living things on Earth are made up of a high percentage of an element called carbon. Most carbon on Earth is not radioactive, but a very small percentage is. Thus, as living things take in carbon, they inevitably will take up a small amount of radioactive carbon into their bodies, and when they die, they will stop taking in this radioactive carbon.

Scientists can look at the amount of decay in a fossil's radioactive carbon and determine how long ago it died. Radiocarbon dating has become an invaluable tool for archaeologists, geologists, and anthropologists. Radiocarbon dating has significantly changed our approach to history during the last 50 years.

Promethium

Promethium(Pm) is a radioactive element with atomic number 61. It was discovered by Jacob A. Marinsky, Lawrence E. Glendenin, and Charles D. Coryell, in 1944,while analyzing the byproducts of uranium fission that were produced in a nuclear reactor located at Tennessee.

● *Radha Nair*



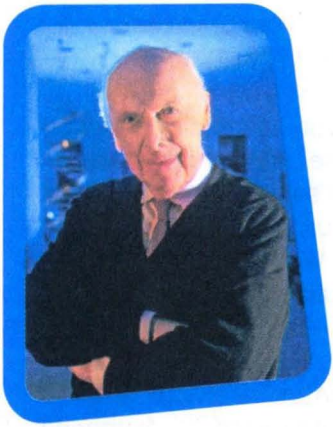
Why was the discovery of ferrocene an important chapter in chemistry?

Ferrocene, also called dicyclopentadienyl iron, is the earliest and best known of the so-called sandwich compounds. Ferrocene occurs as highly stable orange crystals with a melting point of 174° C. Chemically, ferrocene behaves like benzene, and other aromatic compounds.

In 1951, Pauson and Kealy at Duquesne University discovered ferrocene accidentaly. Its distinctive 'sandwich' structure led to an explosion of interest in other such compounds that are now known as organometallic compounds – and this, in turn, led to a new branch of chemistry known as organometallic chemistry. In 1973, Fischer and Wilkinson shared a Nobel Prize for their work in organometallic chemistry.

AAS

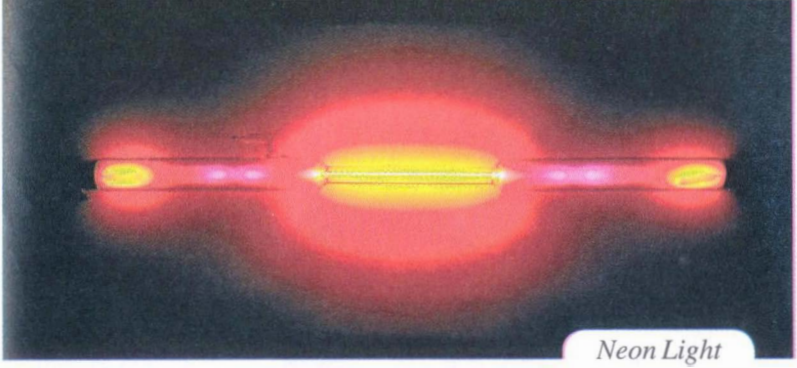
AAS stands for atomic absorption spectroscopy. It was first used as an analytical technique, and the underlying principles were established in the second half of the 19th century by Robert Wilhelm Bunsen and Gustav Robert Kirchhoff.



Francis Crick

Who discovered the structure of the DNA?

Francis Crick and James Watson, together with Maurice Wilkins, won the 1962 Nobel Prize in Medicine for their discovery of the structure of DNA. Crick and Watson studied the structure of DNA, which is the molecule that contains the hereditary information for cells. Maurice



Neon Light

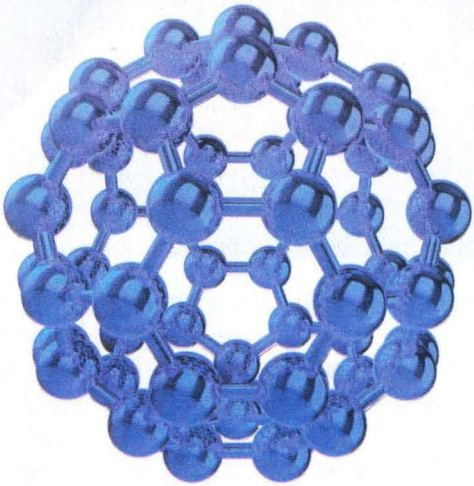
Wilkins and Rosalind Franklin, in London, were using X-ray diffraction to study DNA, and Crick and Watson used their findings in their own research.

In April 1953, they published the news of their discovery, a molecular structure of DNA based on all its known features - the double helix. The work of these four scientists set the stage for the rapid advances in molecular biology that continue to this day.

Why did the production of xenon hexafluoroplatinate prove to be a milestone in chemistry?

Scientists had always believed that noble gases, also known as inert or rare gases, were chemically unable to react. It was thought that the noble gases helium, neon, argon, krypton, xenon, and radon could not form compounds because their electronic structure was extremely stable.

However, in 1962, a Canadian chemist, Neil Bartlett, found that a true xenon compound could be formed when he produced xenon hexafluoroplatinate. This proved to be a milestone in chemistry, because, xenon hexafluoroplatinate became the world's first noble gas compound. It also saw the dawn of a new branch of chemistry- that of noble gas chemistry-which has today become an important tool for developing new and useful compounds. Spurred by Bartlett's success, other scientists soon began to make new compounds from xenon and later, radon and krypton.



What are fullerenes?

A fullerene is a 60 atom carbon molecule. It is a perfect sphere of 60 carbon atoms, which are joined in 12 pentagons and 20 hexagons, like the patches on a soccer ball. It has a hollow cage-like structure. Because the structure looks like a geodesic dome, the molecules were named after the originator of such domes, R. Buckminster Fuller. Fullerenes were first discovered in 1985. They are highly stable chemically, and have a variety of unusual properties. Fullerenes are widely used in medical, pharmaceutical and defence industries, and as lubricants and electronic displays.

Why is the discovery of conducting polymers a landmark in chemistry?

Polymers are molecules that form long repetitive chains, and the nature of the polymer depends on the composition of the chain, and its structural arrangement. Plastic is one of the best known polymers, and normally, plastic do not conduct electricity. Such polymers are used as electrical insulators.

However, in 1977, A.J. Heeger, A. Macdiarmid, and H. Shirakwa discovered that a polymer, polyacetylene, when doped with iodine, could conduct electricity. This was the first conductive polymer that was developed. This development was important, since these polymers are very much like plastic, and one could combine them with conventional plastic to create a product that possesses the qualities of both the materials- for example, one can develop a material that can conduct electricity as well as a metal wire, and yet be as flexible as plastic. These scientists won the Nobel Prize in 2000 for their discovery.

The Secret of Plant Cooking

You know that plants make food through the process known as photosynthesis. However, the chemical process underlying this process was understood only in the second half of the twentieth century, when an explanation was provided by the American chemist Melvin Calvin along with Andrew Benson and James Bassham.

● *Sneha Rao*

Gerhard Ertl

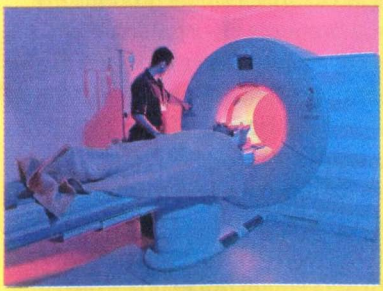
What is surface chemistry?

Surfaces and interfaces are the boundary between a material, and its surroundings.Modern surface chemistry is about molecular-level understanding and the study of surface chemical reactions. Or, to put it in another way, surface chemistry is a chemical phenomenon that occurs at the interface of two phases, usually between a gas and a solid, or between a liquid and a solid. It

examines the properties of chemical surfaces, relying heavily on instruments that can provide a chemical profile of such surfaces.

Whenever a solid is exposed to a liquid or a gas, a reaction occurs, initially on the surface of the solid, and its properties can change dramatically as a result. The work of German scientist Gerhard Ertl focused on this area of chemistry, and he is responsible for developing the methodology for the study of surface reactions in detail.

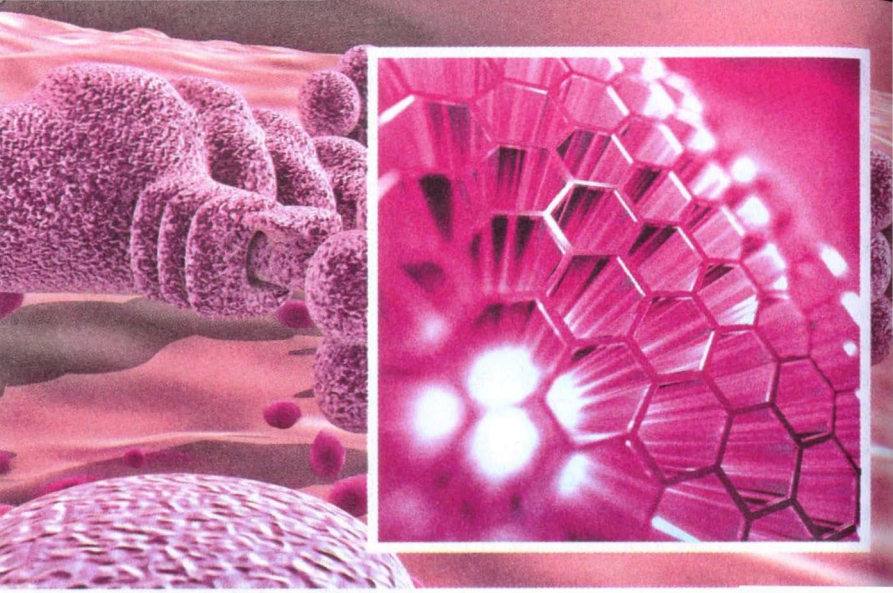
Ertl received the Nobel Prize in 2007 for his work. Surface chemistry has proved to be important for developing better catalysts for more efficient fuel cells.



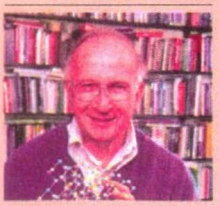
MRI Scanning Machine

MRI

MRI stands for Magnetic Resonance Imaging. It is a method of looking inside the body without using surgery, harmful dyes, or x-rays. Instead, it uses magnetism and radio waves to get a clear inside picture of the human body.



Woodward



Hoffman

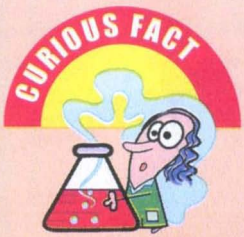
Woodward Hoffman Rules

Robert Woodward and Roald Hoffman were interested in the question of why chemical reactions proceeded in the way that they did- in particular, why certain chemical reactions led to only a single product, when many products were potentially possible. The answer was expressed in a set of statements that have become famous as the 'Woodward Hoffman Rules'. Hoffman was awarded the 1981 Nobel Prize in Chemistry for this work, which he shared with Kenichi Fukui. Woodward had died by then, so he could not be given what would have been his second Nobel prize- he had won one earlier in 1965.

Why is nanotechnology so fascinating?

Nanotechnology is the study and manipulation of matter at the nanometre level – a nanometre is one billionth of a metre. It was Richard Feynman who first described a process in which scientists would be able to manipulate and control individual atoms and molecules. Over a decade later, Professor Norio Taniguchi coined the term nanotechnology. However, wasn't until 1981, with the development of the scanning tunneling microscope that could 'see' individual atoms, that modern nanotechnology began.

Nanotechnology is really fascinating. There are 25,400,000 nanometres in an inch, and a sheet of newspaper is about 100,000 nanometres thick. Today's scientists and engineers are finding a wide variety of ways to deliberately make materials on the nanoscale to take advantage of their enhanced properties such as higher strength, lighter weight, and greater chemical reactivity than their larger-scale counterparts.



Structure of Protein

In 1955, an English biochemist Frederick Sanger, worked first on the insulin molecule ,and then on DNA to open the door to a new era of medicine and biology, especially in the application of genetic engineering. His work was remarkable in that it showed that proteins have a definite structure.

● *DevNath*

Fuel Cell Boat

What are fuel cells?

Fuel cells are devices that produce electricity directly from a chemical reaction. Though they were in existence since the 19th century, serious research on fuel cells began in the 1950s, because of the growing needs of the space programme for electric power to run the essential systems aboard a spacecraft.

Fuel Cell Concept Car

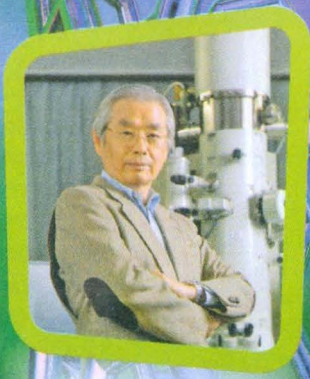
The most common fuel cell uses hydrogen and oxygen, with platinum serving as a catalyst. To put it simply, a fuel cell uses hydrogen as a fuel to combine with oxygen, converting it into water, while producing heat and electricity.

There has been tremendous research into developing better catalysts to increase the life, reliability, and efficiency of fuel cells.

What are carbon nanotubes?

A carbon nanotube is a giant molecule of carbon atoms which has a cylindrical framework in the shape of a tube, with a radius of about a nanometre. Nanotubes can be inserted one into another, and then they are called multilayered. It is only possible to see nanotubes with the help of an electron, or scanning probe microscope.

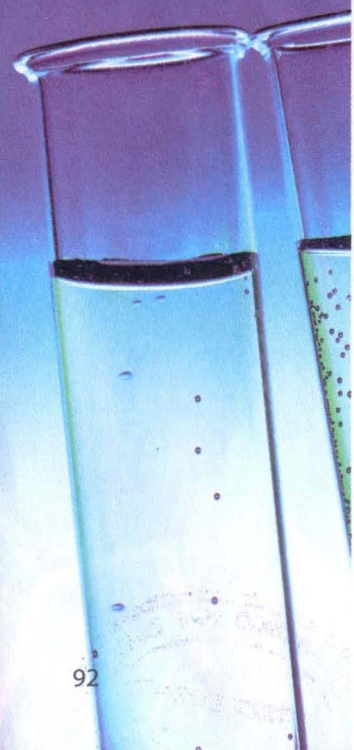
It was in 1993 that Sumio Lijima and Donald Bethune found the single-walled nanotubes known as bucky-tubes. Experiments have measured the tensile strength of carbon nanotubes to be very high- almost a hundred times stronger than that of steel. The strength of a multi-walled nanotube is several times greater than that of a single-walled one. Nanotube are already being used to strengthen tennis rackets. Plans include making ropes out of nanotubes for elevators to supply space stations in geostationary orbits with everything they need.



Sumio Lijima

John Fenn

John Fenn is an American chemist who shared the 2002 Nobel Prize in Chemistry with Koichi Tanaka. Their work has played a tremendous role in the development of new and innovative techniques that allowed researchers to identify and analyze compounds.



Why is 'green chemistry' so important?

Green Chemistry is the study and philosophy of designing products that are not harmful to the environment. The aim is to reduce pollution, as well as to attempt to reverse the damages already created. The need for green chemistry arose because of the hazardous wastes and by-products that are the result of increasing industrialization, and environmentally dangerous forms of progress.

Huge chemical complexes routinely produce significant amounts of waste that ultimately contaminate air, soil, and water, and pose grave threats to the ecosystem.

Instead of focusing on managing the impacts of the hazards in chemicals, a

Quantum Dots

Quantum dots are tiny fluorescent crystals that contain just a few dozen molecules of a semiconducting metal. Quantum dots could soon feature in everything from cell phone displays to digital cinema screens, and quantum dot lighting could soon outstrip even the latest energy-saving fluorescent bulbs and LEDs in terms of power efficiency and better colours.

green chemist would develop safer chemicals and processes which don't use, or create those hazardous materials. The benefits of green chemistry include more efficient use of available resources, reduced utility bills, and more economical waste treatment and disposal. The long term result will be a greener planet for future generations.

What is gene therapy?

Our genes are part of what makes us unique. Inherited from our parents, they go far in determining our physical traits — like the colour of our eyes, and the colour and texture of our hair. Genes are composed of strands of a molecule called DNA, and are located in single file within the chromosomes.

Scientists believe that every human has about 25,000 genes per cell. A mutation, or change, in any one of these genes can result in a disease, physical disability, or shortened life span. These mutations can be passed from one generation to another.

Gene therapy attempts to treat genetic diseases at the molecular level by correcting what is wrong with defective genes. The genes responsible for the disease first need to be identified, and to do this, genetic testing is undertaken. Once the gene has been identified, gene therapy is started. It is an emerging medical technology that involves the addition of DNA to the human genome in order to replace a defective gene. Gene therapy carries the promise of cures for many diseases, and for types of medical treatment most of us would not have thought possible.

GK CONTEST - 6 WINNERS

Winners of the GK Contest - 6, Space Quiz - held in the November issue of Tell Me Why.

1. Nikhil.S.Naveen
Standard X, Kensri School, Bangalore.

2. Jyotiranjit Singh,
Sangramgarh Colony Palta,
North 24 Parganas, West Bengal.

3. Ibrahim.Y.Arab
Darbar Galli, Faderi school compound,
Arab tailor, Bijapur.

4. Aachal Sharma
Class-7, SMQ 137/4,
Air Force Station Darjipura,
Vadodara, Gujarat.

5. Abhiruchi
Class: IX, H.No 42,
Sri Venkat Sai Enclave, Jillelguda,
Hyderabad.

GK Contest - 6 Space Quiz ANSWERS

1. Vikram Sarabhai 2. GSLV
3. EDUSAT 4. Thumba

GK CONTEST - 8

GREAT WRITERS

Here's a contest for our readers. Identify the six WRITERS, from the pictures given here. All you need to do is send us an email naming each person with the proper number.

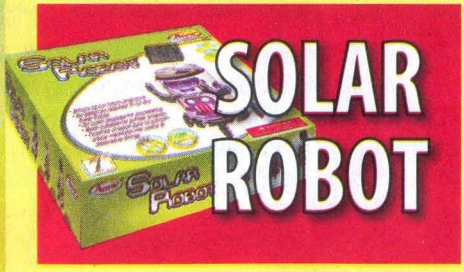
(PLEASE GIVE YOUR POSTAL ADDRESS ALSO IN THE EMAIL) You are also welcome to send your answers by post.

Five winners will be awarded prizes. In case there are more than five correct entries, the winners will be chosen by lot.

Last Date to receive entries:
2014 January 25th

Our e mail address:
childrensdivision@mmp.in
Please enter
TMW - GK CONTEST - 8
in the subject line of your email.

SCIENCE KIT
FOR FIVE LUCKY WINNERS



If you are sending your entry by post, superscribe this on your envelope.

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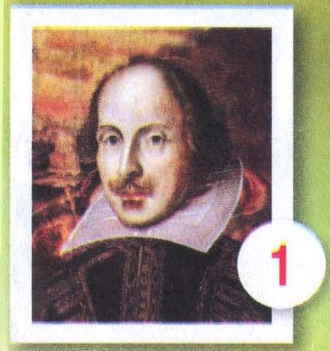
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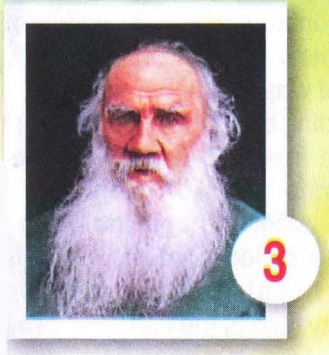
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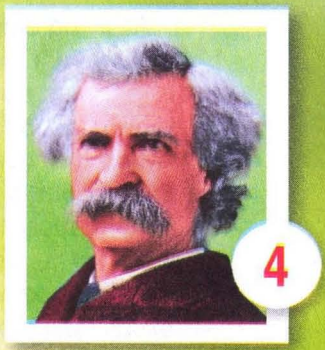
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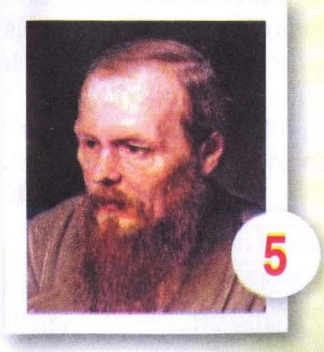
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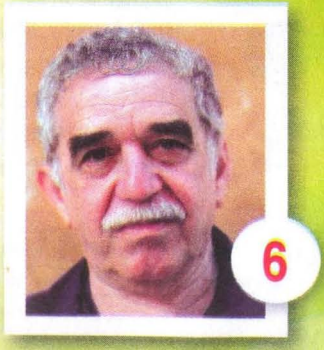
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I Wonder Why?

Send us your questions
E mail: tellmewhy@mmp.in

Question of the Month

Do fish get thirsty?

All living beings, including fish, need water to survive. One feels thirsty when one's body is in urgent need of water. A fish may get this feeling too, depending on its living conditions. A fish that lives in fresh water may not get thirsty, but a marine fish will. Marine fish continuously lose water through their body walls by a process called osmosis. This is because sea water has a higher concentration of salt than the body fluid of the fish.

Due to this water loss, a marine fish drinks water. Otherwise, it will be dehydrated and feel thirsty. The excess of salt the fish absorbs from sea water is excreted by the gills. Fresh water is a more dilute environment, and so water keeps coming into the body of a fresh water fish. So there is no need to drink extra water.

● *Alwin George*

MANORAMA TELL ME WHY - 100 MILESTONES IN CHEMISTRY

Editor: Ammu Mathew Editor-in-Charge: A.V. Harisanker*

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